SHOP EQUIPMENT NUMBER

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CONTENTS

The Machine Tool Situation

With the railroads in the market for approximately $15,000,000 worth of machine tools and with the Ordnance Department requiring a number of special tools valued at the same amount, to say nothing of the requirements of other war industries, the tool manufacturers of this country are face to face with a problem which must be solved and which will necessitate an increase in the capacity of their plants. Undoubtedly the requirements of the Ordnance Department will be considered first, but that does not mean that the requirements of the railways can safely be neglected. The shop and enginehouse equipment of the railroads has for years been notoriously deficient. These conditions were largely responsible for the condition of the motive power last winter, and every attempt should be made to put the power in good shape for the coming winter. Without cars and locomotives, and enough of them fit for active service, the production of the country will be seriously curtailed, with a corresponding effect on the part this nation will play in the war. Upon the response of the machine tool builders to the demand for machine tools depends to a very large extent the effectiveness of our railroads and all our war industries.

The Winning of the War Depends on Output

"The money cost of anything," says Arthur T. Hadley, president of Yale University, "is the amount of dollars and cents which we pay for it. The real cost is the amount of labor and sacrifice which we undergo in order to win it. This war is not fought with dollars and cents—it is fought with labor and with the products of labor, with men and ammunition, with railroads and ships, with coal, and iron and wheat." This statement brings home clearly a fundamental principle of economics. Money is a mere medium of exchange. Work, the amount of it and the economy with which it is used, determines the wealth of a warring nation. We all pat ourselves on the back when we learn of the large number that subscribed to the Liberty Loans; but money is no measure of patriotism, particularly when it is invested in a gilt edge security. It is the self-sacrifice, hard work and the increasing of one's efficiency that count and will do most towards winning the war. Upon the workingman in the United States rests a tremendous responsibility. It is upon his output that the success of the Allies depends. It is no longer a question of how much he earns, but *how much work he produces.*

Changes in the M. C. B. Rules of Interchange

By far the greatest problem to be considered at the meeting of the Master Car Builders' Association in Chicago this month, is the revision of the M. C. B. Rules of Interchange. The unification of the railways in this country under the Railroad Administration has made it possible to inaugurate more economical methods of interchanging cars and of making repairs. Already various local agreements have sprung up in different sections of the country, which expedite the matter of repairs in interchange. This has been done with the cognizance of some of the regional directors and at the present time no absolutely unified code of rules is being practiced.

The M. C. B. Association has a splendid opportunity of revising the method of handling repairs and interchange to

suit the new conditions. Strictly speaking there is no foreign car. The quicker the mechanical department officers and their forces recognize this, the sooner will the beneficial effect of unification be felt. From this broad view of the situation there is much to be done to the M. C. B. Rules. If it is not done by the Association there is no question but what others in authority will insist upon a revision, or revise the rules to suit themselves.

"Uniformity of Hours"—Demands of Labor

Elsewhere in these pages we have commented on the patriotism of labor. We find there are some who want something for nothing. The Rock Island Federated Trades have forced the Rock Island Lines, through the Railroad Administration, to work all the shops in either the car or locomotive departments the same number of hours that any other one shop is worked. That is, if because of the locomotive situation at one point it is found necessary to work a shop 10 hours a day, every other locomotive shop on the system, will work ten hours a day, regardless of the amount of work to be done! Does this represent a true American spirit? What logical reason is there for holding under pay thousands of employees doing nothing while possibly a few hundred are working hard to catch up?

Early in March the Rock Island Federated Trades endeavored to put this ruling into effect on the Rock Island. They succeeded in doing so a month later. They are now asking pay for the men who would have spent their time idle in the shops had their requests been granted at the first appeal. This point, we understand, has not yet been settled. Can the nation afford to pay the wages of idle men while their comrades work? Is it truly American to "hold up" the government in this way? Will this not lead to disastrous results as the roads become thoroughly unified? Permitting the number of hours of work to be regulated by the most crowded shop means a great waste of money.

Another Fuel Shortage Predicted

The men attending the recent convention of the International Railway Fuel Association at Chicago were given a new idea of the seriousness of the problem of supplying coal for all the nation's needs during this year. It is one of the big tasks of vital importance to the successful prosecution of the war and one in which railroad men must play a large part. The Fuel Administration states that 650,000,000 tons of bituminous coal will be needed this year. As compared with the normal consumption of three years ago this represents an increase of 200,000,000 tons. This increase in the coal traffic, which must be carried by the railroads, is enough to fill 16 tracks of gondola cars reaching from New York to San Francisco.

To meet the requirements for this year, there must be mined and transported every week 12,500,000 tons of bituminous coal. Up to the present time the *maximum* production for any single week has never been more than 95 per cent of the required *average* production. The prospect for any great increase in the output of the mines is slight. Unless the difference between the country's requirements and the actual production can be saved, it will be necessary again to shut down industries, with the resultant loss and suffering.

The United States Fuel Administration, the Railroad Administration and the fuel administration of the various states are doing their best to meet the impending crisis. Everyone can help the cause, none more effectively than the railroad man. One of the important factors restricting the output of the mines is the shortage of cars. Anything that is done to increase the car supply, either by keeping cars off the repair track or by providing power to move them faster, will make it possible for the mines to furnish more coal.

The railroads use over one-fourth of all the coal mined in this country. Conservation of fuel by the railroads is therefore of the utmost importance. Practically every employee can help in this work of conservation. It has been said that if every man who burns coal will do the best he knows how without a word of new information, the saving will result in plenty of coal for every purpose. The winning of the war may depend upon securing an adequate supply of fuel. Railroad men should work with this thought in mind, and they should carry the message to all with whom they come in contact. They should not only do their part, but so far as they are able, they should see that the other fellow does his share as well.

Expenditures for Mechanical Improvements

The consideration which the request for expenditures to improve mechanical facilities received at the hands of the Division of Capital Expenditures of the Railroad Administration must be a source of great satisfaction to the mechanical department officers. For years these men have included in their annual budgets requests for just such work, only to have them either denied or materially cut. The roads were not allowed to earn enough money to warrant such expenditures. No physical equipment of the railroads has been so sadly neglected as the facilities for repairing cars and locomotives. The Railroad Administration is clearly alive to this situation and is to be congratulated on its clear vision in this respect. The severe weather last winter accentuated the serious effect more than any other thing could have done. The lack of proper facilities for handling repairs to the equipment greatly increased the operating costs and did much to cut down the effectiveness of the roads. With approximately $75,000,000 for shop buildings, enginehouses, etc., and approximately $15,000,000 for shop machinery and tools, the roads, if the work can be done promptly and the necessary material and tools provided, will be in far better shape to provide the necessary equipment for the constantly increasing demands of traffic than ever before in their history.

The Government Orders Standard Locomotives

On April 30 the Railroad Administration placed orders for 1,025 standard locomotives of the twelve different designs which were briefly described in our last month's issue, distributed as follows: 400 light Mikados, 100 heavy Mikados, 35 light Mountain types, 5 heavy Mountain types, 30 light Pacifics, 20 heavy Pacifics, 150 light 2-10-2 types, 35 heavy 2-10-2 types, 50 six-wheel switchers, 150 eight-wheel switchers, 30 (2-6-6-2) Mallets and 20 (2-8-8-2) Mallets. The orders were distributed between two locomotive builders—555 to the American Locomotive Company and 470 to the Baldwin Locomotive Works. Each builder was given some of each of the twelve types to build in order that they may be equipped with the necessary dies and patterns for all of the standard designs. This was done regardless of the fact that by so doing the time of the deliveries of the locomotives would be prolonged.

These locomotives, representing a composite design to operate on the average railroad, will be distributed—as soon as they are built—to those, who in response to the circular issued early in April by Henry Walters of the Railroad Administration, indicated the number of locomotives necessary to meet their requirements for this year. Whether or not these roads will be compelled to pay for these locomotives, or whether they will remain strictly government equipment, has not yet been determined. When the orders were placed, deliveries were promised in July. As this is written, the early part of June, the drawings have not been completed. It begins to look as though there would be no very large number of these locomotives delivered much before September.

The question of specialties to be used on the locomotives is still in the controversial stage. From what little information has been given out regarding these, it is understood that all the locomotives are to be equipped with non-lifting injectors and over half of them will have stokers. All will be equipped with superheaters, brick arches, incandescent headlights, automatic firedoors and other labor saving devices.

Those roads that are planning on using these standard locomotives should at the first opportunity study the details of design in order that the repair points may be properly equipped to handle the repairs to them. If this is not done there is a possibility of the locomotives being held out of service unnecessarily when failures occur. The detail standards adopted on these locomotives will to a very large extent be different from existing standards on most roads. This, therefore, makes necessary a careful examination of the new designs in order that the roads may protect themselves.

Application of the Wage Increases to Shopmen

It was unfortunate that the report of the Railroad Wage Commission was made public before the director general had an opportunity to approve or disprove it. Based on purely theoretical lines, it did not give the railway shopmen the consideration they deserved. In fact, the "increases" were such that had there been no saving clause, many of the shopmen would have owed their companies for over pay. While the method of computing the increases on a sliding scale basis shows a commendable desire to give to those who need most, it did not take into account the practical consideration of the laws of supply and demand. The demand for mechanics and shop labor has increased at a rapid rate ever since the nation entered the war. As time goes on and facilities for manufacturing munitions, ordnance and other war materials increase, demands for this class of labor will be still further increased.

In order to hold the men at all during the past eighteen months, the railroads have been forced to grant considerable increases. It is for that reason that the commission's report, based on the wages in 1915, showed no increase for shopmen. The director general appreciating these conditions has established a minimum wage of 55 cents an hour, which is an increase of approximately 10 per cent more than the men are receiving now and what the commission granted. Regrettable demonstrations have been made against this award in spite of the fact that when he issued it, the director general appointed a Board of Railroad Wages and Working Conditions, which included representatives of the labor organizations. It is to be the duty of this board to pass on all petitions and complaints raised in connection with the award.

Shortly after the award was announced, the representatives of labor raised strong objections to the award and requested a minimum wage of 75 cents an hour. The unreasonableness of this demand is appreciated when it is known that the minimum wage in the shipbuilding industry for machinists is less than 65 cents, for boilermakers and pipefitters about 70 cents, and for blacksmiths about 72 cents. At the plant of one of the locomotive builders the minimum wages for the different crafts are as follows: machinists, 50 cents; boilermakers, 45 cents; blacksmiths, 50 cents, and pipefitters, 50 cents. The maximum rates at this same place are 65, 72, 65 and 65, respectively. The work done at the locomotive building plant is far more comparable with the railway shopman's work than the work done in the shipyard.

Furthermore, the conditions surrounding the work of the craftsman in the shipbuilding industry are far less congenial than the work of the railroad mechanic. A worker in the shipyard takes a gamble on the permanency of his position. He is working under constant pressure; it is difficult for him to find a suitable and congenial place in which to live and bring up his family, and his living expenses are greater than those of the men in railway towns, many of whom own their homes. He is entitled to high wages to make up for these disadvantages. Any demand for an equal rate by the railway shopmen is, therefore, unquestionably unreasonable. There are men at the present time in railway shops, particularly those working piece work, who even under the old regime were making especially large wages. The demand for output has so greatly increased that the pay of these men has been restricted only by the quantity of work they were physically able to do. Frequently we hear of cases where second rate mechanics working as specialists on a single machine, make much more than the foremen and even more than the head of the shop. A 75-cent rate would make these men plutocrats and greatly unstabilize labor conditions.

If any one group of men in a railway shop has a right to complain, it is the foremen. It is impossible to expect these men to remain contented and satisfied with their positions when the men under them and for whose work they are responsible, are receiving more than they. In fact, some of the foremen have returned to the ranks because of the greater remuneration. Unless these men are properly taken care of ither through the newly constructed wage board, or through the general offices of the railroad, efficient supervision cannot be expected, nor that esprit de corps which is so essential in a railway shop.

The Patriotism of Railway Shop Mechanics

"It is the first time in the history of our government that any of its employees have attempted to strike against their government." Director General McAdoo in saying these words sets in bold relief the few men at Alexandria, Va., and at Silvis, Ill., who "deserted" the ranks of the railway shop forces at these points. These men were not satisfied with the minimum wage of 55 cents an hour, even though the director general in announcing this minimum wage made provision for consideration of any objections through a board containing accredited representatives of the railway shop craft organizations. What has become of the patriotism of the American workingman that he should so far forget himself as to respond to the call of STRIKE from —shall we say—a German propagandist? Have these men the interest of the nation at heart? Do they realize that upon their work depends the successful prosecution of the war? Have they forgotten that hundreds of thousands of our American boys in France depend upon them to do their part in delivering supplies and ammunition, that the lives of our soldiers need not be sacrificed?

It is reported that John McManamy, supervisor of equipment of the Railroad Administration, influenced the men of the Rock Island at Silvis, to return to their work as a matter of loyalty to the nation. It is inconceivable to believe that these men went on strike in cold blood and with a full realization of what their action meant to the country and what extreme satisfaction and encouragment it gave the enemy. Strange as it may seem, every one of the two thousand striking men at Silvis subscribed to the Third Liberty loan. The Rock Island was the only road in the west having a full 100 per cent subscription. It shows there is something lacking in our method of teaching the men what their duty to the nation is, and making them understand what an important part they play in helping this nation win the war. There is need for much to be done in this respect. Every shop officer, from the superintendent down to the gang foreman, must talk patriotism to the men. We have had Liberty Loan drives and Red Cross drives—let us now have a *Labor Drive.* Hold noon meetings, talk with the men at their work, in their homes, on the street, anywhere you get a chance. Tell them *why* we must have cars and locomotives and show them the real part they play in the war.

COMMUNICATIONS

INDUSTRIAL FELLOWSHIPS

LAFAYETTE, Ind.

TO THE EDITOR:

Since the publication of my article dealing with the relations between the railroad and the university, which appeared on page 18, of the January, 1918 issue, I have received a number of letters making inquiries as to the nature and conduct of such joint arrangements.

The term "fellowship" has been generally used to denote a plan whereby a college graduate may continue his education, devoting a part of his time to this and a part to work for the benefit of the univeristy. A fellowship is distinguished from a scholarship in that the latter is usually a method of enabling an undergraduate to continue his studies by giving him some form of financial assistance, while a fellowship extends aid to postgraduate workers. The advantage of the fellowship to the individual is that it takes care of his necessary expenses while working for his master's degree. The advantage to the university is that of having the services of a trained assistant at a comparatively small expense. Fellowships have generally been endowed by the university or by friends of the institution with the idea of encouraging graduate work in various branches.

The industrial fellowship represents comparatively a new development. I think the first fellowships of this character were instituted at the University of Kansas in 1907, Robert Kennedy Duncan being responsible for the innovation. In 1911, Dr. Duncan was called to the University of Pittsburgh to inaugurate a similar system there. In 1913, the Mellon Brothers endowed the Mellon Institute for the express purpose of furthering industrial research and from 1911 to the present time there has been a constant succession of investigations at this institution. Investigations made at Kansas and afterwards at Pittsburgh have been largely of a chemical character having to do with the study of various commercial products including metallurgical, medicinal, clothing, food and fuel products. The fellows, working under this system, receive varying amounts from $1,000 a year upwards according to their experience and the importance of their work. They devote all of their time excepting three hours per week to the research work. The funds are supplied by various firms interested and the results of the work become the property of those contributing. The fellow frequently receives a commission or bonus in addition to his salary, dependent on the profits ensuing to the contributors. All the resulting patents must be assigned to the company and the report or monograph becomes its exclusive property for three years. At the end of that time the results may be published by the university unless there is objection. Any questions at issue between the two parties to the arrangement may be settled by a board of three arbitrators appointed in the usual way. This is the most conspicuous example of industrial research in this country and it seems to be eminently satisfactory both to the university and to the contributing interests. The fellows are university graduates from various institutions in this country and abroad. Since 1911, the number of fellowships has increased from 11 to 42, the number of workers from 24 to 65 and the amount contributed from $40,000 to $150,000. The Mellon Institute thus far has given less attention to engineering than to chemical subjects.

At the University of Illinois, in connection with the Engineering Experiment Station, industrial fellowships have been established by the Illinois Gas Association. The fellows are selected from engineering graduates connected in some way with the companies forming the association. Each man works for two years, devoting half his time to research and receiving $500 per year for his services. This enables him at the same time to get his master's degree. The work is naturally of a chemical engineering character. The results, however, are published by the university and become public property, the object of the investigation being not to benefit the separate corporations but the gas business as a whole.

Many of the large industrial corporations, including two or three of the railroad companies, maintain research laboratories of their own where their own particular problems can be solved without any assistance from outside. There are, however, many smaller corporations who do not find it expedient to maintain well equipped laboratories of this sort and who are in the habit of taking various problems to the laboratories of the technical schools for solution. Speaking for the institution which I represent, I may say that Purdue has always carried on work of this kind for the railroads and for various manufacturing corporations. The companies have paid liberally for this service and in the main seem to have been satisfied with the results obtained. These researches are, however, more or less sporadic and their success depends largely on the conditions obtaining at the time when the work is done. It is quite evident that the industrial fellowship would offer a more promising plan. The corporations on their part would have the advantages of regular service in a well equipped laboratory with a staff of trained investigators. The university on its side would have the advantage of contact with the practical problems of the day in a very concrete way. The fellow who is the recipient of the income from the fellowship has an opportunity of pursuing advanced study for his master's or doctor's degree and at the same time of working on a definite industrial problem of commercial value and possibly of working into a permanent position of responsibility. The research engineer of the manufacturing company is usually too much pressed with immediate problems to give proper time and thought to true scientific investigation. The fellow in the university can concentrate his efforts on the one problem at his disposal. This plan may be further expanded by giving the fellow an opportunity to work in the shops and laboratories of the corporation, making his experiments on actual machinery or production in the process of manufacture.

There are a number of important scientific and engineering problems confronting the railroads today. Only a few of the roads can conduct satisfactory research on these problems. By the expenditures of from $500 to $1,000 annually, a railroad might carry on an investigation with good laboratory facilities and well trained assistants. A group of railroads could do much more, while the large railway associations could carry out a plan of this kind with benefit to all the roads in the association since the results would be published in the proceedings and be for the general distribution. The only approach to this thus far is the Ryerson Scholarship which is administered by the Master Car Builders' Association and which takes care of a certain number of students in railway engineering during their college courses. There is no attempt in this to accomplish any work for the railroads but merely to assist in educating railroad engineers. The industrial fellowship promises equal benefits to the individual student and at the same time well repays the railroad.

In view of the many important engineering problems confronting the railroads and the numerous technical universities having laboratories at their disposal, it would seem to be another step forward in conservation and efficiency to combine the two along the lines which have been indicated. It is for the railroads to take the first step, and they may be assured that many if not all of the universities will gladly co-operate.

C. H. BENJAMIN,
Dean, Schools of Engineering, Purdue University.

A Well Organized Repair Shop

A Study of Methods Followed in Repairing Locomotives on the New York Central at West Albany

THE West Albany (N. Y.) shop of the New York Central is located at a particularly strategic point for the section of the road it serves, handling the backshop repairs for practically all of the 1,200 New York Central locomotives operating east of Syracuse, N. Y. There are 22 roundhouses in that section, which call on West Albany for all of the machine work they are not equipped to handle. This shop has 40 working pits in the two erecting shops which extend out from each end and at right angles to the machine shop with a transfer table between them, as indicated in Fig. 1. The shop is not particularly well equipped with machine tools, but with a loyal and enthusiastic organization from the shop superintendent down to sweepers, a very creditable output of repaired locomotives is obtained. Most of the 1,133 men employed operate under the piece work system, working 60 hours a week and they specialize in their work to a high degree. It is the purpose of this article to describe the organization of this shop, calling attention to the methods and practices which make for increased output.

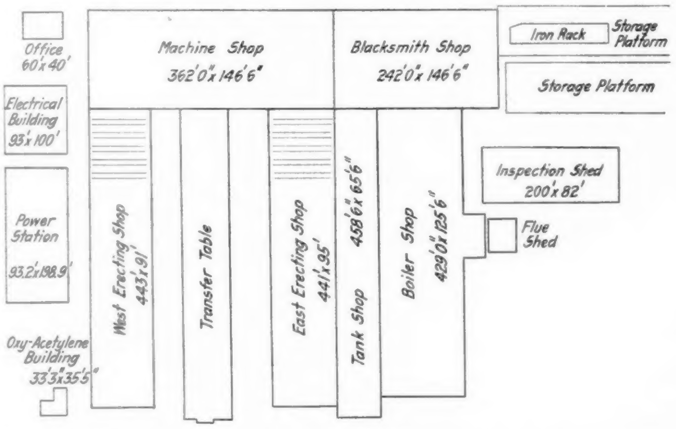


Fig. 1—General Arrangement of the West Albany Shops of the New York Central

SHOP OUTPUT

During the first four months of the present year 458 locomotives, or an average of 114 locomotives per month, were repaired at the West Albany shops with an average force of 1,126 men. This represents a material increase over past years, as indicated in the table of shop output showing the number of locomotives repaired under the different classes for the corresponding months in 1912 and 1917. While 57 of the 128 locomotives repaired during the month of January, 1918, were given light repairs, due largely to the severe weather last winter, it will also be noted that the amount of heavy boiler and machine repairs has been materially increased since 1912. It may also be said that some locomotives receiving practically general repairs were credited with class *F* repairs only because the tires were not turned. This is due to an old established rule and happens whenever a locomotive with light mileage and good tires is badly wrecked.

This increase in output was obtained with a decreasing working force. The average number of men employed during the first four months of 1912 was 1,331, or 205 greater than during the corresponding months in 1918. In addition to this, West Albany has been called upon to repair locomotives for other roads, which has not made maximum output possible. Being unfamiliar with the standards required by other roads, the shop would find it difficult to do the work with as great despatch as was possible on New York Central locomotives. In some cases it was necessary to await instructions and repair parts for these locomotives.

Classification of Repairs and Output at West Albany

1912	A	B	C	D	E	EF	F	Total
January	0	1	3	11	12	3	7	37
February	0	1	11	17	17	1	10	57
March	1	0	9	29	14	7	3	63
April	0	1	4	36	20	3	10	74
1917								
January	0	5	2	17	29	9	16	78
February	0	7	3	8	26	10	6	60
March	0	5	4	26	23	10	14	82
April	0	3	0	28	26	5	13	75
1918								
January	1	3	2	8	39	18	57	128
February	1	3	2	2	44	22	46	120
March	1	6	1	11	43	18	30	110
April	1	5	2	14	47	16	15	100

Class A—New boiler and general repairs to machinery.
Class B—New firebox and general repairs to machinery.
Class C—New side sheets and general repairs to machinery.
Class D—New tubes, tires turned and general repairs.
Class E—Tires turned, general repairs to machinery.
Class EF—Failure of any important part of machinery not due to accident.
Class F—Light repairs to machinery.

The only material improvement in the shops since 1912 which would affect the output was the addition of an outside inspection shed, an addition to the tank shop and the piping of the shop for acetylene gas, which is used almost exclusively for cutting operations. The location of the inspection shed is shown in Fig. 1. The tank shop addition is between the east erecting shop and the boiler shop and

was at one time an open storage platform served by a 20-ton crane.

ORGANIZATION

There are evidently some one or more reasons for the results accomplished at West Albany not accounted for by the shop facilities or the number of men employed and it is not necessary to be at the shop long in order to discover the most important one. It is in the personnel of the management, from the superintendent down to the youngest foreman. Almost without exception each one has risen from the ranks, being a practical man and an expert in his particular line. All the foremen co-operate in the closest possible way and taken together they form an enthusiastic unit in turning out locomotives. They possess the confidence and respect of the workmen to an unusual degree and even the truckers have caught the spirit and appear anxious to keep things moving.

A chart of the organization is shown in Fig. 2, together with the number of men working in each department. Of a total number of 1,133 men employed in March, 1918, some clerks, office men and others not shown under any of the subheads in the diagram are included.

PIECE WORK SYSTEM

Another reason for the improvement in production is undoubtedly the system of payment by piece work that has been developed at West Albany. This system gives the workmen every incentive to speed up, exercise their industry, concentration and ingenuity, and produce results. It works out in practice as follows: In setting the price on a new piece of work, the piece work inspector times the man doing the work and bases a trial price at 25 per cent over his day rate. This price will probably be too high, but as the man becomes more familiar with the work, the price can be lowered and still allow him to make 25 per cent over his day rate. When the inspector gets the trial price to a point which he thinks is fair to the man and the company, it is turned in to the chief inspector, with a detailed description of the work. By comparing it with the prices for the same kind of work at different points on the system, the chief inspector may find that this trial price is still too high, in which case he turns it back to the shop inspector with his decision. The shop inspector then decreases the trial price again, showing the man, if possible, how the work may be done more quickly. The new trial price is then returned to the chief inspector and again compared with the prices at other points. When finally acceptable to the chief shop inspector, the trial price is submitted for approval to the traveling inspector and the supervisor of piece work at New York, and is finally placed on the piece work schedule for that class of work. Once in this schedule, the price is never cut, unless some new device or jig or quicker way of doing the work is developed. But what is done if the men speed up and make too much money? In that case if the quality of the work is up to standard nothing is said. The piece work price as finally set is reasonable and with it the average machinist can make a good day's pay. If he is above the average he gets the extra money; the company gets the work. The policy of not cutting prices has been followed consistently, so that the men have every confidence in the management and it would be hard to find a better satisfied, or more loyal group of men in any railway shop.

TRAINING MEN FOR SPECIAL WORK

Another important practice followed in this shop is the changing of men about until each one finally obtains work to which he is adapted. Many of the men who are doing the best work are not all-around mechanics, but have been developed for the particular job which they are doing. If a foreman knows of a man who he thinks is adapted for a special job, the man is given a chance to show his worth. With no preconceived notions he can make the most of the foreman's instructions and often develops into a valuable man. Very often it happens that one man does all of a certain class of work for the entire shop, but an understudy is usually trained so that no one man becomes indispensable. A special point is made of not blaming a man for the first mistake, as it is figured that the man is always worth more than the job, and according to the old truism, "He who never makes a mistake never does anything."

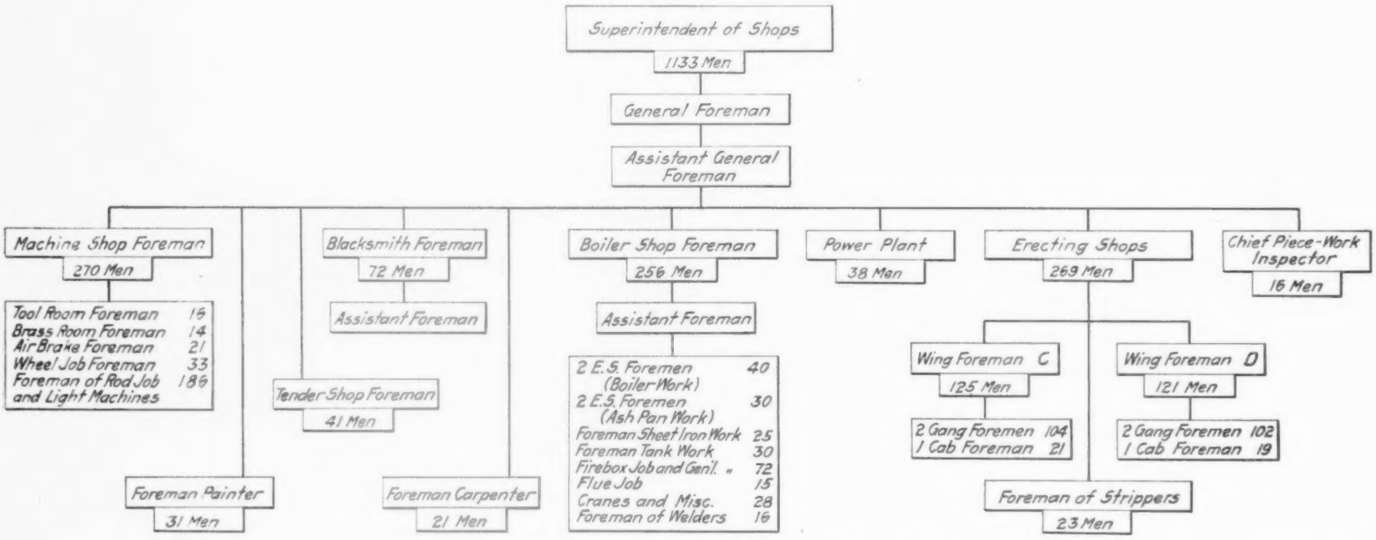


Fig. 2—Diagram Showing the Organization at West Albany

Every effort is made to diminish the trucking about the shop as much as possible by localizing the work. One machinist and an apprentice do practically all of the laying out for the machine shop and go from one place to another, laying out work at the machine on which it is to be done. For example, new main rods are taken from the milling machine to the radial drill, which is nearby and the bolt holes are laid out, thus eliminating movement of the rod to and from a laying out table. Another good example is in the method of machining and laying out cylinders. The cylinder boring machine is located next to the planer and while the boring bar is going through the cylinder the machinist lays out the valve chamber and stud holes. Relief valves and by-pass valves are also laid out so that by the time the boring operations are completed the cylinder is ready for the

drill. The machinist gets an extra rate for this work and the company gets the cylinder so much quicker.

ECONOMY DUE TO ELECTRIC WELDING

The electric welding process as developed at West Albany has resulted in marked economies and it is used extensively on boiler work and for the repair of all kinds of cast iron and steel machine parts. Almost no part is so badly damaged that it cannot be repaired by this method, the only limit being when the value of a new part is less than the cost of welding the old. All broken frames are repaired by electric welding and it is estimated that less than five per cent of these break a second time. All kinds of cylinder welds are made and the success in this field has been largely due to the proper arrangement of holding studs. Welding practice on boiler work is not essentially different from that at other shops, but on the whole West Albany has had better than the average success in welding, particularly in welding cast iron. Broken cast steel wheel centers, coupler bases, trailer spring yokes, etc., are all repaired by electric welding.

There are other examples of what may be done by the welding process, and the resourcefulness of the foreman. One locomotive recently had a wrecked left guide yoke and there was none in stock. A right hand yoke was machined, the ribs and guide knees cut off with the acetylene torch and electric welded back on again on the reverse side, thus making a left hand yoke. The great saving in cost of material and labor effected by welding is largely responsible for the fact that in the past six years the cost of locomotive repairs has not increased over one-quarter of a cent a mile.

The electric welding equipment consists of one alternating current and six direct current machines. The work is done by 16 experienced men who are under the direction of a foreman welder. The success in welding wrought iron and steel is said to depend not so much upon the machine as upon the operator and especial attention is given to training each man. Many welders hold too long an arc and use too much current, with the idea of doing a quick job, but the experience at West Albany has shown that a close arc gives better results as a rule, and that the best current to use is from 120 to 140 amperes with 12 to 20 volts.

SHOP SCHEDULE

The schedule system as originally installed at West Albany has been discontinued, although certain features are still maintained, such as the weekly calendar showing the date locomotives are due out. It was felt that foremen could keep in closer touch with the work by following it personally than to get their information from a schedule clerk, and the present system is believed to be more flexible in case it is necessary to replace one locomotive by another. Each Thursday night the boiler shop foreman gives the general foreman a list of the boilers that are to be tested the following week. Friday morning the general foreman with the erecting shop foremen personally inspect each locomotive and together they decide on the day it will probably go out. This date is put on the weekly calendar, later to be distributed throughout the shop, and each man then knows not only the order in which to work on the locomotives, but by experience, how long before the "due out" date his particular work must be done. In case a broken cylinder is discovered or other unexpected job, it is easy to substitute another locomotive and thus keep the weekly output fairly constant. In addition to the Friday inspection, the general foreman makes an inspection of the locomotives each morning and in this way keeps in the closest possible touch with the situation. There is a staff meeting of all foremen Monday, at which matters of general interest regarding the work are discussed.

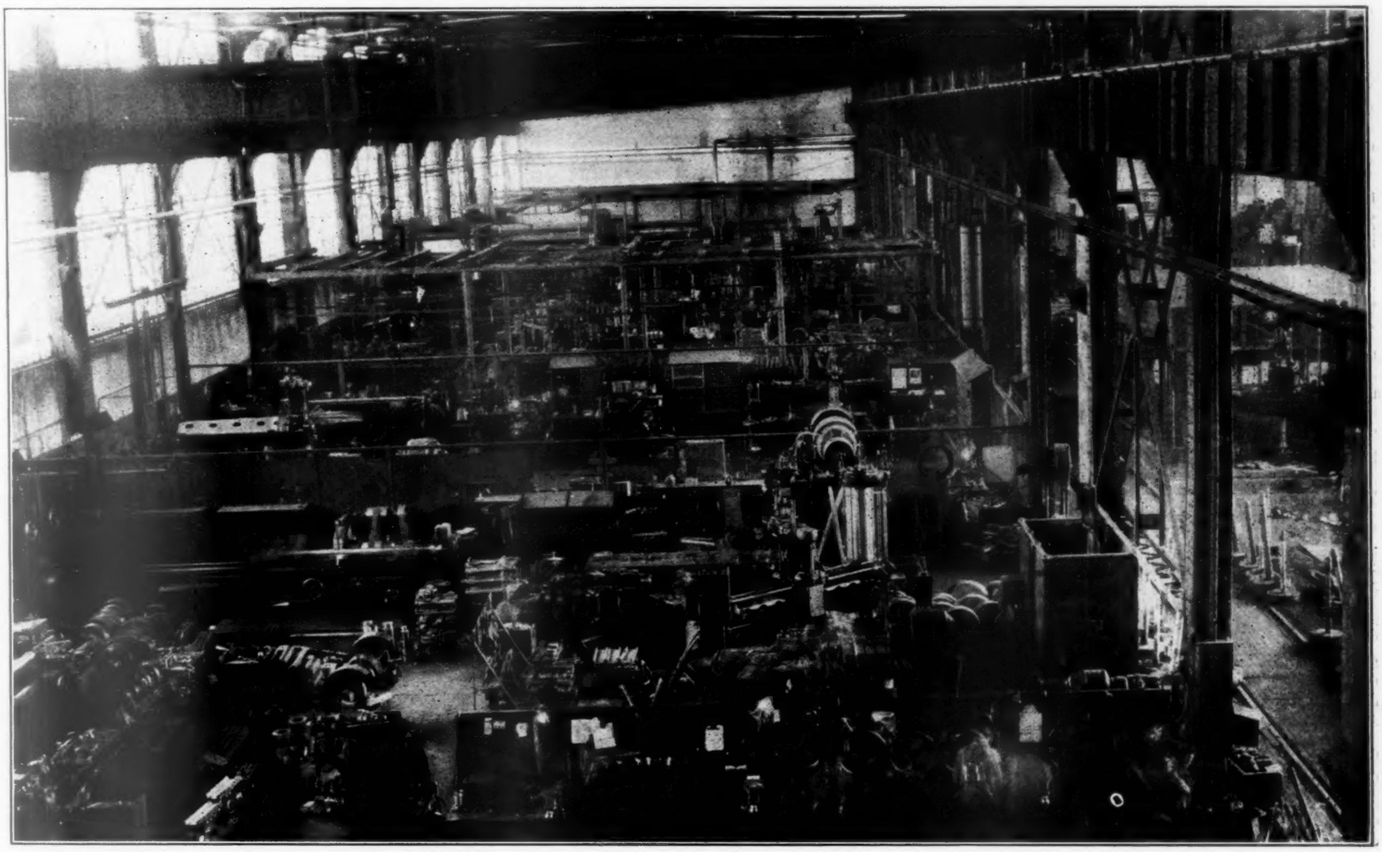


Fig. 3—General View of North Side of Machine Shop

MACHINE SHOP

The department that limits the output at West Albany is the machine shop and it has been found necessary to work

a small number of machinists nights on those jobs that are behind. The wheel job is somewhat delayed by the need of more crane service and a large tire boring mill which was promised for last spring, but which was requisitioned for government service. It is planned in the near future to install an additional turret lathe for the special purpose of making link pins and bushings. The fit of the pins in the bushings will be made standard and by making these pins in quantities on the turret lathe, a large saving is anticipated.

A general view of the north part of the machine shop is given in Fig. 3. The link and piston jobs are in the foreground. The central enclosed section is the tool room. Fig. 4 shows the south section of the machine shop. This is devoted almost entirely to driving wheel work. The foreman's office is shown near the center of the shop with a 100 per cent Liberty loan flag over the door.

The machine shop output has been increased by many slight changes in machines and one of these is shown in Fig. 5. A journal lathe was changed by putting 7-in. filling blocks under the head and tailstocks and the tool post, thus making possible the turning of cut trailer journals without removing the wheels.

The simple expedient of clamping a bench vise to the table of a drill used for miscellaneous work reduced the cost of drilling almost a third. This arrangement is shown in Fig. 6 and the casting being drilled is a pipe manifold. Fig 7 shows the way in which wrist pin washers are machined on an arbor twenty at a time. These washers are later bored in lots of six by the same machinist and he is able to make from 60 to 70 a day. It may be said in passing that the workman on this machine is one of the greatest producers in the shop. Knowing that the piece work prices are fixed, he works hard and it is not uncommon for him to receive as much as $250 per month. He is an exceptionally rapid and efficient workman.

THE ROD JOB

With a required output of three to four sets of heavy rods per day, it means that men on the rod job must make the most of every minute. The work is under the direct supervision of one of the assistant foremen who has several able machinists on the work. Fig. 8 shows the horizontal milling machine on which new rods are milled, and particular attention is called to the arrangement used for holding the rod. It is held on centers and supported as shown by four screw blocks and a central jig with taper attachment to raise or lower the parallels. When it is desired to mill the opposite side of the rod, the wedges and blocks are loosened and the rod turned on the centers and made parallel with the bed by the screw blocks. By this means the total time of setting up the work is much reduced. The man who does this work has been on the job for seven years and understands it so thoroughly that while the machine is worked to its utmost capacity, it is able to do all of the rod milling work.

A vertical miller which machines the end of the rods is also worked to capacity and by a man who understands how to get the most out of the machine. The general rule at West Albany is to work the tools to the most economical feed and speed and to work the machines until, judging by the sound, they are carrying all that is safe. One boring mill only is used in making the rod bushings and boring the brasses, and here again, a man of especial ability is used on the job. He is not an all around machinist, in fact having been taken from the boiler shop, but he has learned that particular machine and would be a hard man to replace.

Driving Boxes and Wheels.—Needless to say, one of the important parts of the work is the repairing of driving boxes and wheels. It is possible to heat three sets of driving wheel tires in the large tire heating furnace at the same time and this is a material help in increasing the output. Another thing that helps the floor men is the setting of all crank arms and making the keys before the wheels are sent

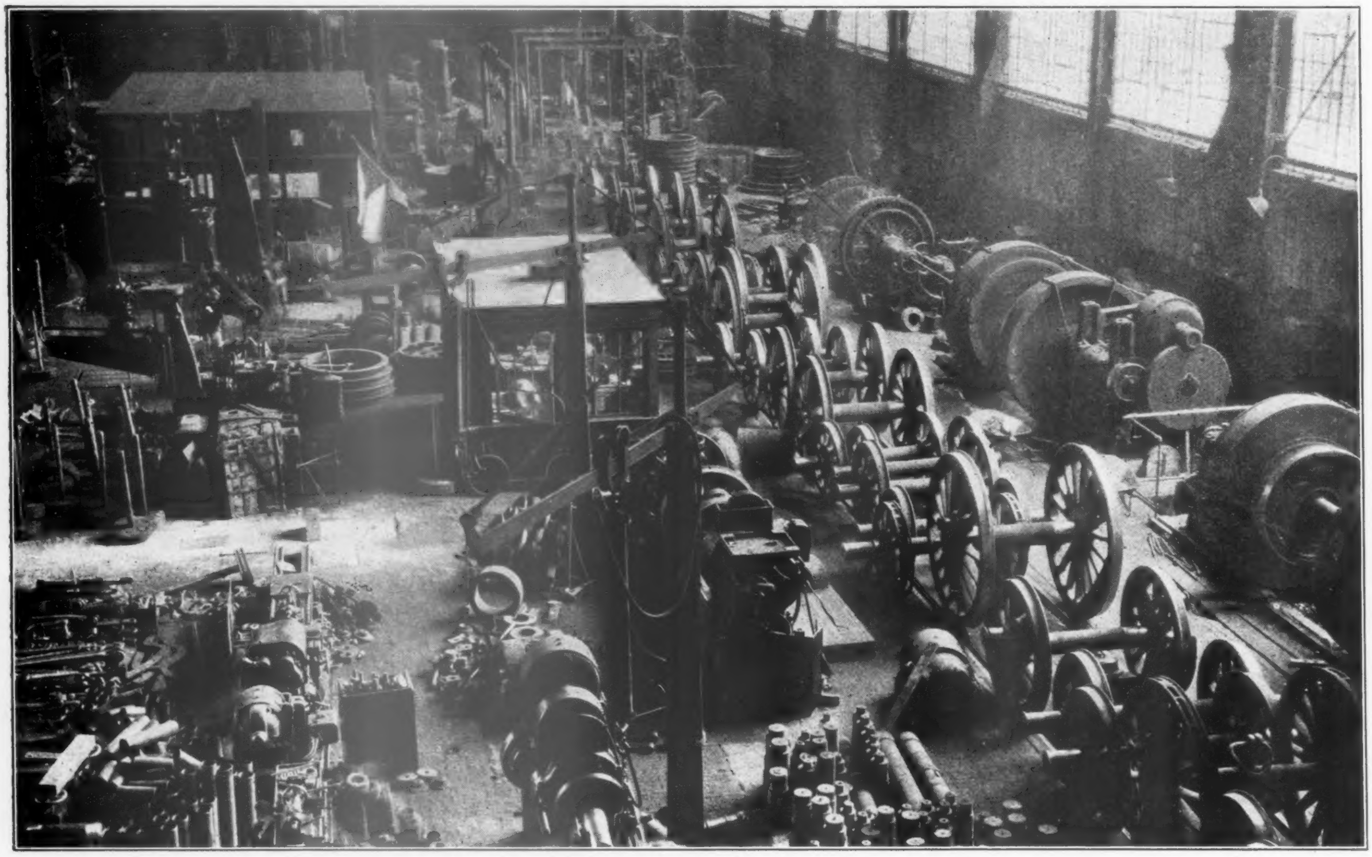


Fig. 4—General View of South Side of Machine Shop

to the floor. A special gage is used, which insures accuracy, and with the crank arms set correctly, the valve setter's work is much easier. The practice in handling box work is particularly interesting and should receive especial notice. The crown brass fit in the driving box is made on a slotting machine which machines all brasses under 19 in. in length.

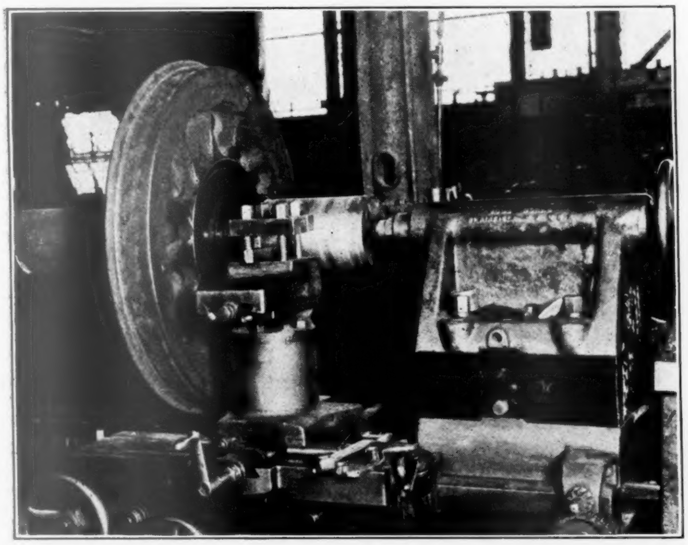


Fig. 5—Journal Lathe Arranged to Turn Trailer Journals Without Removing the Wheels

One man operates this machine, fitting about twenty-four brasses a day besides pressing the old ones out and the new ones in. He makes on an average eight dollars a day and is able to turn out the work on account of long experience and natural aptitude.

The Gisholt boring mill, shown in Fig. 9, is used for boring boxes and is also worthy of note, because it is especially designed for this work and handles from 24 to 28 driving boxes a day. A special patented chuck, shown in Fig. 10, made by the Gisholt Machine Company is used with the mill and it eliminates much of the time previously spent in laying out boxes. The box is centered automatically and bored by means of a special boring bar. After the box has been bored, it is possible to adjust the chuck off center so that the grease clearances may be cut without reclamping the box.

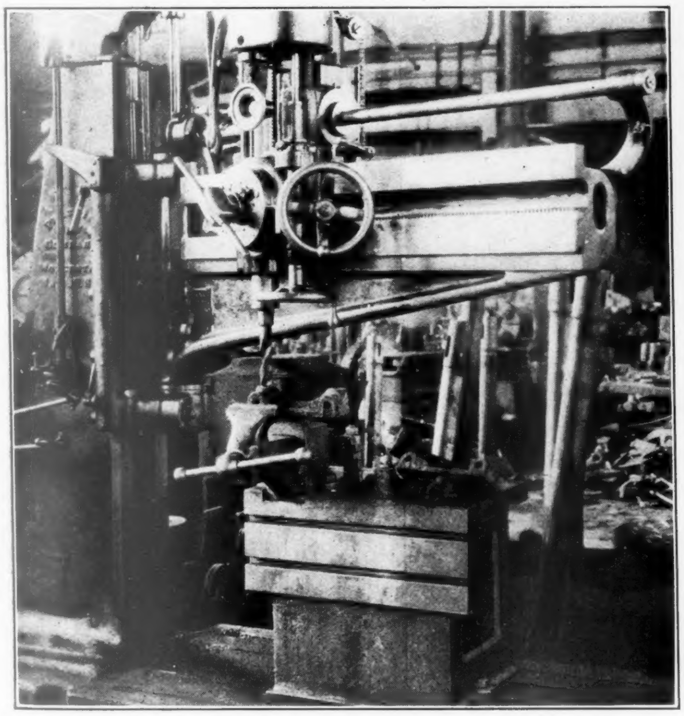


Fig. 6—Bench Vice Used in Connection With a Radial Drill

The operator of this machine is an all-around mechanic, who has been in the service of the company for 23 years and averages $175 a month on this work. He offers an excellent example of the way in which West Albany workmen look ahead to their work, co-operate with their foremen and are interested in seeing the locomotives go out. He takes special pride in the condition of his machine. He provides himself with any necessary repair parts and usually makes the repairs to the machine. Such interest as this would be hard to find in a shop where men are not proud of their work and anxious for big production.

The boring mill which recesses the driving boxes for brass side bearings is an old machine and is one of those which it is necessary to work at night in order to keep up with the work. Under the present arrangement, two machinists are able to fit all of the boxes to the journals and put up the cellars, making the wheels ready to go under the locomotive. This work is done under a runway equipped with two pneumatic hoists.

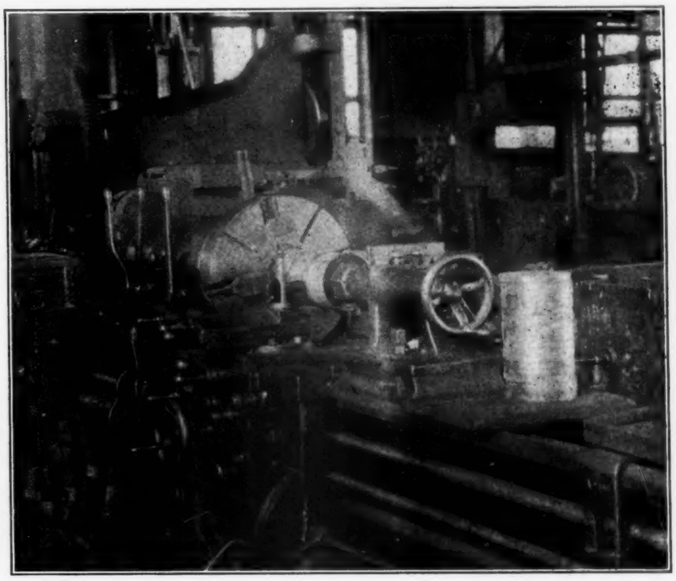


Fig. 7—Turning Twenty Wrist Pin Washers at One Time

Two brass furnaces of the cylindrical type are used and all crosshead shoes are brassed in addition to the driving boxes. The making of brass castings for other parts of the shop is discouraged, but in case of an emergency any brass machine part not carried in stock may be cast. Some way is always found out of the difficulties that arise on the box job and the foreman with his initiative, enthusiasm and good judgment usually points the way.

Grinding Work.—There are two grinding machines at West Albany, one an old machine used in grinding truck journals, and the other a comparatively new Norton gap grinding machine used for grinding piston rods, shafting, crank pins, valve stems, axles (after being rough turned), and piston heads when they are nearly to the limiting size. Another job which is done very advantageously on this grinder is the finishing of piston valve packing rings. Ten rings are machined, cut, compressed and placed in a special holding jig between the centers of the grinder, as shown in Fig. 11. They are then ground and when placed in a newly bored valve chamber will expand to fit the bushings, making practically a perfect job. In connection with the grinding of journals, it may be stated that these journals

are rolled after grinding, the idea being to obtain a harder bearing surface more like that of a second hand journal.

Piston Job.—The method of applying piston heads to the rods at West Albany is worthy of note, in view of the excellent results obtained. The heads are heated in a specially constructed furnace and shrunk on to the rod, an allowance of 1/80 in. to the foot being made; the piston rod nut is applied as usual in other shops. This method has proved very effective in reducing the number of loose heads and when removing a head from a rod, it is necessary to do so in the big wheel press, often requiring a pressure of 200 tons.

Planing Shoes and Wedges.—Exceptionally good work is being done on the shoe and wedge planer shown in Fig. 12. The operator has so familiarized himself with the work and the best methods of grinding and setting up his tools, that he is able to machine the driving box fit on about forty shoes and wedges a day. Referring to the illustration, he will be seen taking a cut 1⅜ in. deep in one operation. No finishing cut across the shoe is necessary. The cut shown is about all the machine will stand and could not be taken unless the tool was ground and set properly.

AIR BRAKE REPAIRS

The method of making air brake repairs is not materially different from that at other shops, but the output is exceptionally good, considering the number of men employed. Five men working on No. 5 New York Duplex air compressors repair from 45 to 50 a week or an average of almost two pumps a day per man. As these compressors are rated at $4.39 a piece complete, it will be seen that the men are making very good pay, but it is also true that a man who did not understand the work could hardly repair one pump a day and even that might be rejected on account of not standing the test. The entire question hinges on the fact that a capable mechanic who works on the same job long enough will systematize his work, will know just how accurately it must be done and make no lost motions. The result is that he accomplishes more and with apparently less effort than another mechanic who is perhaps a good man, but inexperienced.

Fig. 8—Milling Side Rods

All of the foundation brake rigging is handled and repaired in this department and there is a considerable saving due to having the job localized and not trucking the parts back and forth through the shop. All of the valves, such as brake valves, triple valves, feed valves, straight air brake valves, etc., are repaired by three men, who also are experienced men and make every move count.

The test rack was designed by the air brake foreman and is considered one of the most complete racks in use. It is fitted to test any and all of the air brake valves that are used on the New York Central equipment. An attempt has been made to establish, as near as possible, service conditions and the compressor supplying air is arranged to give 140 lb. pressure. The reservoirs are of the same capacity as those used on the locomotives and there is sufficient piping to give the train-line the capacity of a 50-car train. The signal line piping has the capacity of a 25-car train, and by means of ingenious arrangements of clamping, it is possible to test any part of the air brake equipment quickly and conveniently.

Fig. 9—Turning Driving Boxes on Gisholt Boring Mill

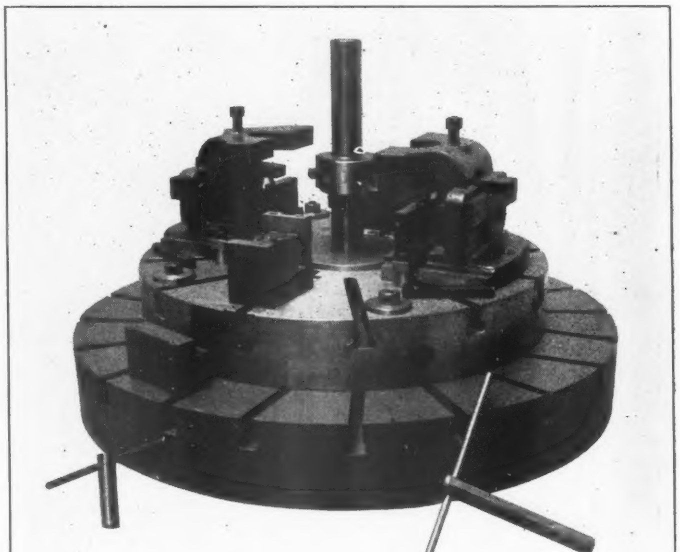


Fig. 10—Special Chuck Used on Gisholt Machine

TOOL ROOM

The tool room at West Albany is a large one and formerly employed 35 men, but under the leadership of the present

foreman and the inspiration of his methods of working, the present force of 16 men does all of the work. The tool room must be prepared to make repairs on all of the machinery, shafting, cranes, etc., at West Albany in addition to considerable roundhouse work and new work, such as dies, milling cutters and new jigs. In the past seven years probably 800 sets of dies have been made. That this work can be done with a reduced number of men is largely due to the foresight of the foreman, who plans ahead and tries to be prepared beforehand for all emergencies. The tool room is

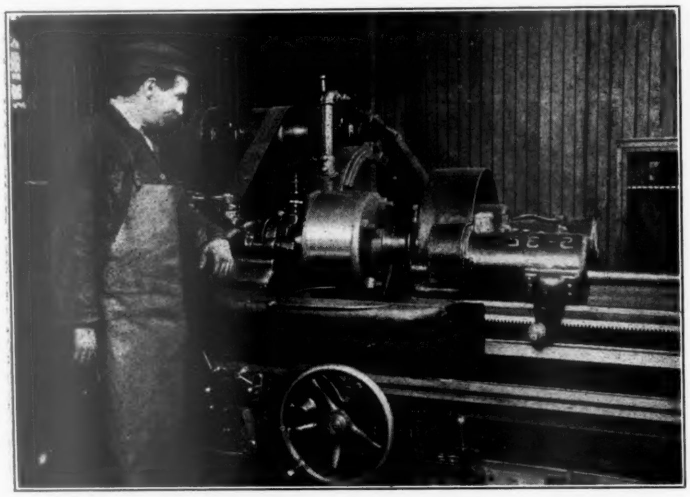


Fig. 11—Grinding Piston Valve Packing Rings

well equipped with modern machinery and one of the most interesting is a surface grinder equipped with a magnetic chuck. This machine is used in the manufacture of straight edges, gages, dies, etc., also in the case of broken axles, when it is desired to examine the structure of the steel, a sample piece is usually slotted off and then ground to a perfectly true surface on this machine.

BRASS ROOM

The work in the brass room is handled by 16 men, mostly specialists. The injector job in particular is noteworthy,

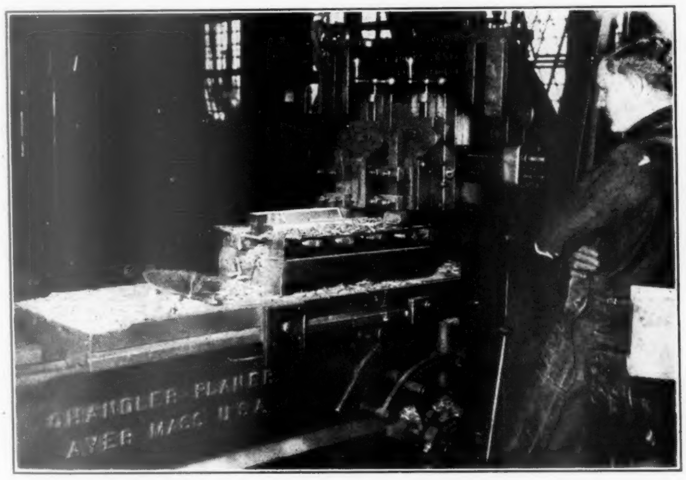


Fig. 12—Machining Shoes and Wedges

because practically all of the injectors including those sent in from roundhouses are repaired by one man. He has been 20 years with the company and spent most of that time on the injector job. On account of his ability and knowledge of the work he can repair from 30 to 35 injectors a week. Most of the repair parts in the brass room are carried in stock and are not made up from new material unless they happen to be out of a particular part needed, in which case a brass casting may be made in the foundry and machined. One of the main reasons for the success of the brass room has been the standardization of tools and equipment. Most of the machine work is handled by four Fox lathes, all of which are alike and have interchangeable chucks, tools and jigs. The advantage of this arrangement will be evident to all who are familiar with the loss due to duplicating equipment.

BOILER SHOP

The boiler shop work at West Albany is strictly up to date and very seldom is a locomotive held up for the lack of a boiler suitably repaired to go into service. Take for example the method of constructing a firebox after it is laid out and punched. The entire list of operations from shearing, scarfing, rolling and chipping the flanges, to riveting, caulking and putting the box into the casing, are often performed in 10 hours. Holes are laid out and punched beforehand, no time is lost in fitting and every man knows his job.

The work in the tube shop is interesting on account of the fact that no new tubes have been bought for four years. This has been made possible by the use of a reclaiming machine which was built by the shop men and is used to weld the tubes in the center. Thus two old tubes that have been safe-ended four or more times have the safe ends cut off and are welded together at the center to make one new tube. If this tube is to be used in passenger service, it has to be steel safe-ended. All tubes are tested under compression at 600 lb. The method of handling superheater flues is also

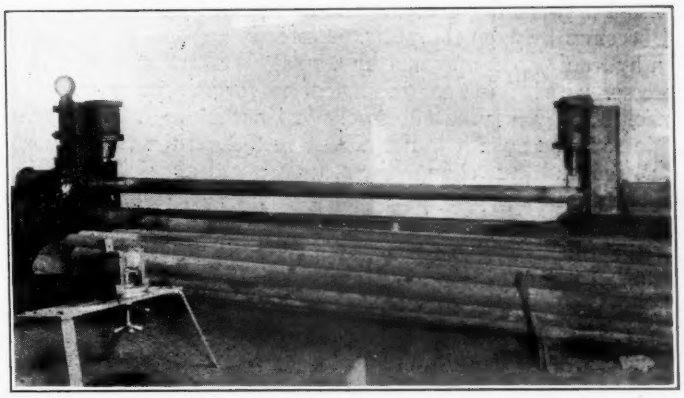


Fig. 13—Testing Superheater Flues

of interest and special machines have been developed for welding and testing. Fig. 13 shows the machine used in testing and the method is as follows: The safe-ended superheater flue is placed in the machine and firmly held at the left hand end. The right hand end is supported and firmly clamped in a carriage which is free to move on small roller wheels. Both ends are plugged by air operated caps, the water for testing being admitted through the left hand plug. The pressure is then raised to 250 lb. and inasmuch as the right hand support is free to move, the result is that the flue is subjected to a tension equal to 250 lb. times the cross sectional area of the flue. This test approximates service conditions and has proven very satisfactory.

The boilers are usually washed out at night and as a rule ten boilermakers are employed at night to help out on any work that may have been delayed.

BLACKSMITH SHOP

The spring work is done in the smith shop. Adequate machinery is provided so that six men are able to turn out from 1,500 to 1,800 springs per month. An efficient stripping machine is used in removing the bands and with this machine it is possible to remove even the heaviest bands quickly and without damaging them. The banding machine provides a pressure of 100 tons and compresses the sheaves

as it presses the band around them. The testing machine is conveniently placed and each spring is tested to see that it conforms to the specifications.

In view of the extreme importance of keeping down drawbar failures, the New York Central has specified that only the best hammered iron should be used in making them, and drawbars are made from home-made billets. The following method of making the billets is used: The best quality of iron is bought made up in the form of 4-in. by 1-in. bars and cut up into 8-in. and 16-in. lengths, being made into piles about 14 in. high. The piles are put in the furnace and heated to a welding temperature and are hammered into shingles, which are usually about 1½ in. by 14 in. by 4 ft. The shingles are then welded together, enough being used to give a billet of the required thickness. By this method well hammered stock of the first quality is obtained for making drawbars, crank arms, valve motion work, etc. A comparison of relative costs, including the cost of new material, cutting, shingling and making into billets indicates that there is perhaps little saving in this method, but the best quality of stock is obtained, and when it is wanted, which is not always possible when purchasing on the open market. In case the welded shingles are forged immediately the cost is less.

A special upsetting and lengthening machine, shown in Fig. 14, is in use in this shop and aids very materially on certain kinds of work. This was devised by Mr. Stock, the assistant blacksmith foreman. It is provided with four vertical cylindrical posts set eccentric, so that with any work placed between them, the harder it is pulled apart, the tighter it becomes between the posts. Power is applied by means of an hydraulic ram operated by a small Westinghouse air compressor which has been reconstructed for this purpose. The machine may be used effectively in lengthening or shortening side rods, because it is not necessary to heat the rod above a dull red and thus change the structure and physical qualities of the steel. Drawbars may also be lengthened or shortened on this machine. No tram is necessary, as the gage shown in the illustration indicates at a glance just how much the material has been upset or lengthened. That this machine is a time saver is shown by the reduction of 45 per cent in piece

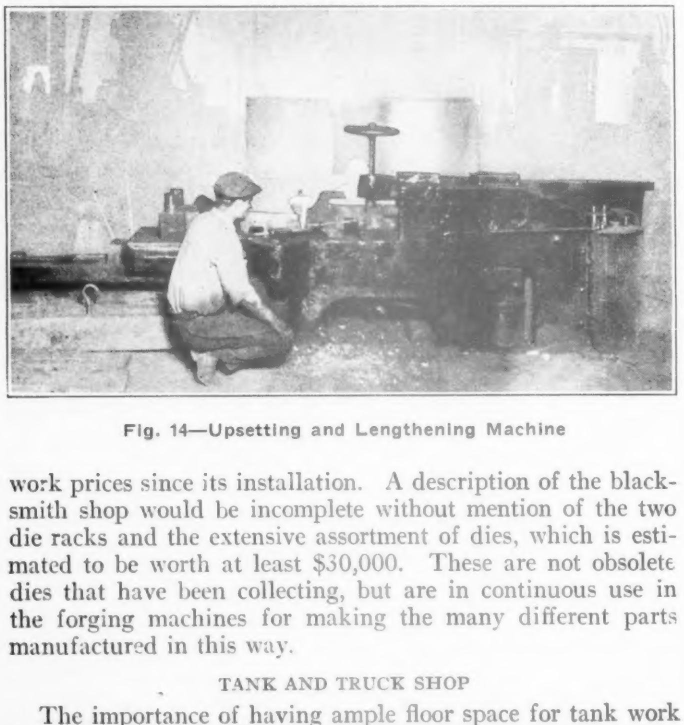


Fig. 14—Upsetting and Lengthening Machine

work prices since its installation. A description of the blacksmith shop would be incomplete without mention of the two die racks and the extensive assortment of dies, which is estimated to be worth at least $30,000. These are not obsolete dies that have been collecting, but are in continuous use in the forging machines for making the many different parts manufactured in this way.

TANK AND TRUCK SHOP

The importance of having ample floor space for tank work is proved by the increase in output due to the construction of the new tank shop at West Albany. The capacity of this shop is practically 100 tanks a month and here again, the electric welding process has had an important part to play. In case the back end of a tank is wrecked, the whole end is cut off with the acetylene torch, removed, straightened and put up again, with a T-iron on the inside to break the joints.

In the truck shop there is a large journal lathe which is set below the level of the floor so the wheels may be easily rolled on to the lathe and the journals turned without removing the wheels. It handles about 500 pairs of wheels a month.

ERECTING SHOP

With 40 working pits the average output of the two erecting shops is over two locomotives a pit a month and it would be possible to obtain three instead of two provided the

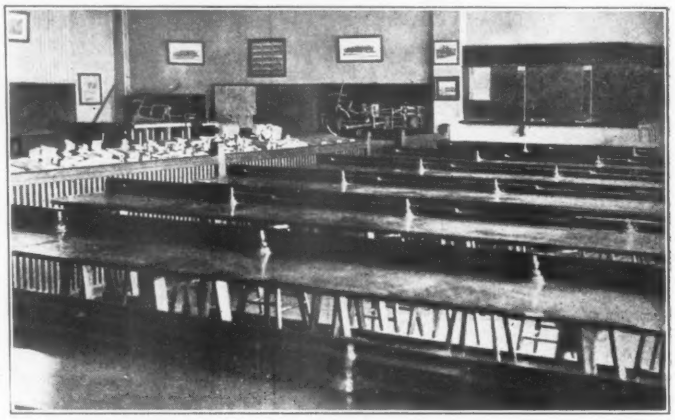


Fig. 15—Apprentice Schoolroom at West Albany

capacity of the machine shop could be increased. Under the present system the heavy repair locomotives are usually on the pit about eight days, but some take longer than this and on the other hand, when a locomotive comes in in especially good shape, it is often possible to so speed up the machine work that the locomotive is returned to service in less than eight days. A recent example of the quick work done in the erecting shop was the delivery of a boiler and the placing of it in the frames Thursday morning, and the completion of work by Saturday noon. During that time the boiler received its test and had all leaky tubes removed and renewed. As stated under the subject of electric welding, the extent to which this process has been developed is largely responsible for the good showing of the erecting shop.

APPRENTICE SCHOOL

The method of instructing the apprentices at West Albany is particularly good. The chief draftsman instructs the boys in the principles of mechanical drawing, drawing of details, freehand sketching and tracing when the boy shows especial aptitude. Two hours a day, twice a week, are allowed the boys for classroom work and they are paid for this time at their regular rates. The last half hour of each period is devoted to class problems in arithmetic and certain of the simpler laws of mechanics, such as the law of levers, the inclined plane and the relation of pulley diameters to respective speeds, are carefully explained.

The class room is well supplied with models, as shown in Fig. 15 and those models applying to the shop work include a Walschaert valve gear, a Baker Pilliod valve gear and a model to be used in lining shoes and wedges, and guides. This work comes under the direction of the shop instructor, who has held the position for nine years and understands not only what the boys should be taught, but how to present it in an interesting way. One thing which has proved very beneficial to the boys has been the assignment of home work from a text book used in conjunction with shop work. For instance, if the boy is working on a planer, he is assigned a certain lesson from a text book which deals with planer con-

struction and operation and such problems as may arise. At the present time the apprentice school includes 101 boys and so far as possible each one is given personal instruction. It is obviously impossible, even in a four year course, to give the boys a comprehensive knowledge of all the work done in the shop, but they are placed with the best mechanics and given every opportunity to improve in judgment and knowledge as they go from job to job. As usual most of the apprentices are working to become machinists.

That the possibilities for a bright, ambitious boy are good in the apprentice school, is illustrated by the case of one boy who in slightly less than three years after completing his apprenticeship has become a foreman in the boiler shop.

CONCLUSION

Locomotives are needed now and will be needed more next winter. They are needed for the support of our industries and the carrying out of a successful war program. That West Albany is doing much to forward this program cannot be denied and the way it is done is by the co-operation of an able management with earnest workmen, all of whom are using their heads and pulling together.

WAGE INCREASE FOR RAILWAY MEN

A Minimum Hourly Wage of Fifty-Five Cents for Mechanics Allowed—Dissatisfaction Among the Men

THE news from the Railroad Administration at Washington during the past month of most interest to railway employees was the announcement of the findings of the Railway Wage Commission. The commission recommended increases estimated to amount to about $300,000,000, reaching the conclusion that the fairest method of dealing with the problem was to award increases on a percentage scale ranging from $20 a month for those receiving $46 a month and under down to $1 for those receiving $249. These percentages were based on the scale of December, 1915, and any increases since that time were to apply on the commission's scale. But the important proviso was included that reductions in hours were not to be regarded as increases in pay, thereby giving the men in train service additions under this scale to those obtained through the eight-hour law.

The commission's recommendations were made after an exhaustive investigation of the increased cost of living; it was found, for example, that each dollar now represents in power to purchase a place to live, food to eat and clothing to wear but 71 cents as against 100 cents on January 1, 1916.

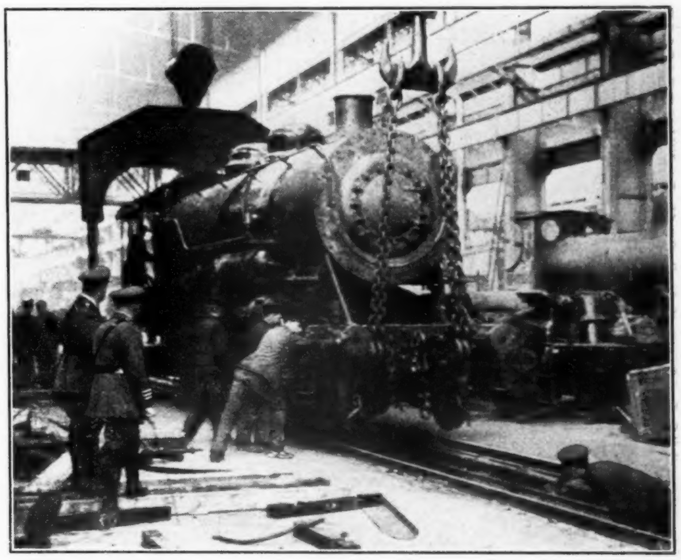
The commission's suggested scale is as follows, the amounts by $5 divisions only being shown:

THE SCALE RECOMMENDED

1 To the monthly rate of pay of men receiving in December, 1915, the amounts named in this column	2 Add the per cent named in this column	3 Equivalent to amount named in this column	4 Making new rate per month as shown in this column
Under $ 46.00	....	$20.00	....
$ 46.01 to 47.00	43.00	$20.00	$ 67.21
50.01 to 51.00	42.35	21.60	72.60
55.01 to 56.00	41.00	22.96	78.96
60.01 to 61.00	41.00	25.01	86.01
65.01 to 66.00	41.00	27.06	93.06
70.01 to 71.00	41.00	29.11	100.11
75.01 to 76.00	41.00	31.16	107.16
80.01 to 81.00	40.44	32.75	113.75
90.01 to 91.00	36.38	33.10	124.10
100.01 to 101.00	31.29	31.60	132.60
110.01 to 111.00	27.12	30.10	141.10
120.01 to 121.00	23.64	28.60	149.60
130.01 to 131.00	20.69	27.10	158.10
140.01 to 141.00	18.16	25.60	166.60
150.01 to 151.00	15.96	24.10	175.10
160.01 to 161.00	14.04	22.60	183.60
170.01 to 171.00	12.34	21.10	192.10
180.01 to 181.00	10.83	19.60	100.00
190.01 to 191.00	9.48	18.10	209.10
200.01 to 201.00	8.26	16.60	217.60
210.01 to 211.00	7.16	15.10	226.10
220.01 to 221.00	6.15	13.60	234.60
230.01 to 231.00	5.24	12.10	243.10
240.01 to 241.00	....	9.00	250.00
249.01 to 250.00	....	.00	250.00

All advances suggested are effective January 1, 1918, and are retroactive. The back pay due on June 1 is estimated at $125,000,000.

The Director General approved these recommendations with certain changes in General Order No. 27 issued May 25. The most important of these changes from the mechanical department standpoint is one establishing a minimum rate of 55 cents an hour for machinists, boiler makers, blacksmiths, and other mechanics who receive the same basis of rates. Common labor is granted an increase of 2½ cents an hour in excess of the rate on December 31, 1917. Another marked deviation from the recommendations of the Railway Wage Commission is one wherein the basic eight-hour day is established. This does not reduce the hours of employment as at present worked, nor does it increase the total compensation fixed in the order for the number of hours now worked in excess of eight hours, but it does establish the basic



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The Successful Outcome of the War Depends No More Upon These Men Than Upon Railway Shop Men at Home

eight-hour day upon which further wage adjustment may be based. The order of the Director General also creates an advisory board of Railroad Wages and Conditions consisting of J. J. Dermody, F. F. Gaines, C. E. Lindsey, W. E. Morse, G. H. Sines, and A. O. Wharton, of which Mr. Sines was appointed chairman.

Sections *C* and *D* of the Director General's order deal respectively with hourly and piece work scales, principally of the shop trades are reproduced in part herewith:

While it is expected that the Board of Railroad Wages and Working Conditions hereinafter created shall give consideration to all questions of inequality as between individ-

uals and classes of employees throughout, sufficient information is available to justify certain conclusions with respect to the mechanical crafts, and in the case of machinists, boilermakers, blacksmiths, and other shop mechanics who have been receiving the same hourly rates, the increases named in this order shall apply, with a minimum wage of 55 cents per hour. It is recognized that this may still leave among shop employees certain inequalities as to individual employees, to which the Board of Railroad Wages and Working Conditions will give prompt consideration.

SECTION C.—RATES OF WAGES OF RAILROAD EMPLOYEES PAID UPON HOURLY BASIS.

[Rates of pay in cents per hour.]

Old rate per hour[1]	New rate per hour	Old rate per hour[1]	New rate per hour	Old rate per hour[1]	New rate per hour	Old rate per hour[1]	New rate per hour
10	19.75	38	53.75	66	78.50	94	102.50
10.5	20.25	38.5	54.25	66.5	79.00	94.5	102.75
11	20.75	39	54.75	67	79.50	95	103.25
11.5	21.25	39.5	55.50	67.5	79.75	95.5	103.75
12	21.75	40	56.00	68	80.25	96	104.25
12.5	22.25	40.5	56.75	68.5	80.75	96.5	104.50
13	22.75	41	57.25	69	81.25	97	105.00
13.5	23.25	41.5	57.75	69.5	81.50	97.5	105.50
14	23.75	42	58.25	70	82.00	98	106.00
14.5	24.25	42.5	58.50	70.5	82,50	98.5	106.25
15	24.75	43	59.00	71	83.00	99	106.75
15.5	25.25	43.5	59.50	71.5	83.25	99.5	107.25
16	25.75	44	60.00	72	83.75	100	107.50
16.5	26.25	44.5	60.25	72.5	84.25	100.5	108.00
17	26.75	45	60.75	73	84.50	101	108.25
17.5	27.25	45.5	61.25	73.5	85.00	101.5	108.75
18	27.75	46	61.50	74	85.50	102	109.25
18.5	28.25	46.5	62.00	74.5	86.00	102.5	109.75
19	28.75	47	62.50	75	86.25	103	110.00
19.5	29.25	47.5	63.00	75.5	86.75	103.5	110.50
20	29.75	48	63.25	76	87.00	104	111.00
20.5	30.25	48.5	63.75	76.5	87.50	104.5	111.25
21	30.75	49	64.25	77	88.00	105	111.75
21.5	31.25	49.5	64.75	77.5	88.25	105.5	112.25
22	31.75	50	65.00	78	88.75	106	112.75
22.5	32.25	50.5	65.25	78.5	89.25	106.5	113.00
23	33.00	51	65.75	79	89.75	107	113.50
23.5	33.75	51.5	66.25	79.5	90.00	107.5	114.00
24	34.50	52	66.50	80	90.50	108	114.25
24.5	35.00	52.5	67.00	80.5	91.00	108.5	114.75
25	35.50	53	67.50	81	91.50	109	115.25
25.5	36.00	53.5	68.00	81.5	91.75	109.5	115.75
26	36.75	54	68.25	82	92.25	110	116.00
26.5	37.50	54.5	68.75	82.5	92.75	110.5	116.50
27	38.25	55	69.25	83	93.00	111	117.00
27.5	39.00	55.5	69.75	83.5	93.50	111.5	117.25
28	39.50	56	70.00	84	94.00	112	117.75
28.5	40.25	56.5	70.50	84.5	94.50	112.5	118.25
29	41.00	57	71.00	85	94.75	113	118.50
29.5	41.75	57.5	71.50	85.5	95.25	113.5	119.00
30	42.50	58	71.75	86	95.75	114	119.50
30.5	43.00	58.5	72.25	86.5	96.00	114.5	119.75
31	43.75	59	72.75	87	96.50	115	120.00
31.5	44.50	59.5	73.00	87.5	97.00	115.5	120.00
32	45.25	60	73.50	88	97.25	116	120.00
32.5	46.00	60.5	74.00	88.5	97.75	116.5	120.00
33	46.75	61	74.50	89	98.25	117	120.00
33.5	47.25	61.5	74.75	89.5	98.50	117.5	120.00
34	48.00	62	75.25	90	99.00	118	120.00
34.5	48.75	62.5	75.75	90.5	99.50	118.5	120.00
35	49.50	63	76.00	91	99.75	119	120.00
35.5	50.25	63.5	76.50	91.5	100.25	119.5	120.00
36	51.00	64	76.75	92	100.75	120	120.00
36.5	51.50	64.5	77.25	92.5	101.25		
37	52.25	65	77.75	93	101.50		
37.5	53.00	65.5	78.25	93.5	102.00		

[1] "Old rates" are those of December, 1915.

For common labor paid by the hour, the scale named herein shall apply with the provision, however, that as a minimum, 2½ cents per hour will be added to the rates paid per hour, as of December 31, 1917.

METHOD OF APPLYING INCREASES TO HOURLY RATES

(1) Machinist worked in January, 1918, eight hours per day, 27 days, total 216 hours straight time.

The rate of pay for this position in December, 1915, was 34 cents per hour; new rate under this order 48 cents per hour, but with minimum rate of 55 cents per hour as herein ordered, will receive		$118.80
In January, 1918, his rate of pay was 37½ cents per hour, for 216 hours, equals		81.00
Difference one month		$37.80
On basis of working same amount straight time each month for Five months (January 1 to May 31)		189.00
Also worked in same period 90 hours overtime at time and One-half, new 55 cents minimum rate, or 82½ cents, equals	$74.25	
Was paid at 37½-cent rate pro rata overtime or	33.75	
		23.62
Balance due January 1 to May 31, 1918		$212.62

(2) Machinist worked in January, 1918, 10 hours per day, 26 days, total 260 hours straight time.

The rate of pay for this position in 1915 was 34 cents per hour; new rate under this order, 48 cents per hour, but with minimum rate of 55 cents per hour as herein ordered will receive		$143.00
In January, 1918, his rate of pay was 37½ cents per hour; 260 hours equals		97.50
Difference 1 month		$45.50
On basis of working same amount of straight time each month for 5 months (January 1 to May 31)		227.50
Also worked in same period 90 hours overtime at pro rata rate, new 55-cent minimum rate, equals	$49.50	
Was paid at 37½-cent rate pro rata overtime or	33.75	
		15.75
Balance due January 1 to May 31, 1918		$243.25

(3) Machinist "D" was employed in the same shop in December, 1915, and in 1918 on the same class of work. His hourly rate in December, 1915, was 35 cents for 9 hours, 26 days a month. He was paid for overtime and Sunday work at time and one-half. On January 1, 1918, his hours were reduced to 8 and his rate increased to 40 cents. The new hourly rate applicable to his 1915 rate, viz.: 49½ cents being less than the minimum of 55 cents, his new rate will be 55 cents per hour. In 1918, from January 1 to May 31, he worked 234 hours per month or an average of one hour overtime daily on the 1918 schedule. This for five months gives him 130 hours overtime. He has been paid as follows:

1,040 hours straight time, at 40 cents	$416.00
130 hours overtime, at 60 cents	78.00
Total	$494.00

His back pay will be computed as follows:

1,040 hours straight time, at 55 cents	$572.00
130 hours overtime, at 82½ cents	107.25
Total	$679.25
Deduct payment at 1918 rates	494.00
Back pay due	$185.25

and his future rate per hour will be 55 cents.

(4) In the case of employee "E," who was employed in a shop where the rate for his position was 35 cents per hour for 8 hours' work in 1915, with time and one-half for overtime, but in the same position and same shop with the same hours in 1918 his rate is 45 cents per hour; his earnings in 1915 in the standard 208-hour month would be $72.80 per month, and he would be entitled to the new hourly rate of 49½ cents per hour. His straight time and overtime earnings and back pay would be computed in exactly the same manner as machinist "D." The principles illustrated will apply to all men paid by the hour, whatever their occupation may be.

METHOD OF APPLYING INCREASES TO PIECE RATES

(1) The pieceworker shall receive for each hour worked, the same increase per hour as is awarded to the hourly worker engaged in similar employment in the same shop.

(2) If the hourly rate has been increased since 1915 to an amount greater than the increase herein fixed, then the higher rate shall prevail.

(3) Where there was no piece rate for an item or operation in the piece-rate schedule of 1915, adjust the current price by such an amount as a similar item or operation has been increased or decreased since December 31, 1915, or as near such a plan as practicable.

(4) It is understood that the application of this order shall not, in any case, operate to reduce current earnings.

(5) When a pieceworker works overtime or undertime, he shall receive that proportion of the increase provided in the schedule which the time actually worked bears to the normal time in the position.

(6) Overtime is not to be considered solely as the number of hours employed in excess of the normal hours per month in the position, but rather the time employed in excess of the normal hours per day.

(7) Employee "F" was employed under a piecework schedule in a shop where the basic hourly rate was 35 cents for eight hours, with time and one-half for overtime. This rate under the plan illustrated above will be increased to

49½ cents per hour. The difference is 14½ cents per hour.

Regardless of the schedule of piece rates under which he is paid, under this order "F" will be entitled to receive 14½ cents per hour in addition to his piecework earnings for every hour worked in 1918 unless the hourly rate shall in the interim have been raised and a proportionate increase made in the piecework schedule.

For example: Assume that "F" made $90 in December, 1915, at his piecework. At the hourly rate he would have earned only $72.80, and his hourly rate must therefore be increased to 49½ cents.

If, in January, 1918, he has attained sufficient skill to earn $100 on the same piecework schedule, he will be entitled to receive, nevertheless, 14½ cents per hour for each hour of straight time worked, and for each hour of overtime, 21¾ cents additional (if time and one-half for overtime is in effect).

Assume that in the five months, January 1 to May 31, "F" has worked 1,040 hours straight time, and 130 hours overtime, and has, at his piece-work schedule, earned $500. He will be entitled, nevertheless, to receive as back pay, the following amount:

1,040 hours at 14½ cents per hour	$150.80
130 hours at 21¾ cents per hour	28.28
	$179.08

But if in January, 1918, the basic hourly rate had been increased to 50 cents, and this increase had been correspondingly expressed in his piece-work schedule, he would be entitled to no back pay. If, on the other hand, the hourly rate had been increased from 35 cents in 1915 to 45 on January 1, 1918, and this increase had been expressed in a corresponding increase in the piece-work schedule, then "F" would be entitled to receive back pay at 4½ cents per hour for straight time and 6¾ cents per hour overtime.

If the practice in the shop, however, had been to pay pro rata for overtime, then the rate for such overtime since January 1, 1918, would be pro rata at 4½ cents, or 14½ cents per hour, according to whether piece rates had been or had not been increased.

(8) Employee's December, 1915, rate was 38½ cents; which rate in this order for 8 hours per day entitled him to 54¼ cents per hour. His basic rate had, by January 1, 1918, been raised to 42½ cents per hour. Piece work rates had not been raised in the interval. This man earned in 208 hours $100. He is entitled to a raise of 11¾ cents per hour.

11¾ cents × 208:

1 month	$24.44
5 months	122.20

DISSATISFACTION WITH THE INCREASES ALLOWED

Very regrettable demonstrations against the increases allowed have taken place on the Southern at Alexandria, Va., and on the Rock Island at Silvis, Ill., where the men actually struck. This was particularly uncalled for as the director general had taken pains to form a new board consisting of representatives of the Brotherhood of Railway Trainmen, Railway Telegraphers and the head of the Railway Employees' Department of the American Federation of Labor, together with ex-railroad men, to consider and pass upon all petitions and complaints regarding the working out of this new wage plan. The director general was very rightly disturbed at the action of these employees and sent the following message to the heads of the organizations of the railroad shop men, including the Metal Workers' International Alliance, International Brotherhood of Electrical Workers of America, American Federation of Labor and Amalgamated Shopmen's Machinist Organizations:

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Railway Shop Men of the British Army in France—These Men Are Working on Army Pay; They Will Not Strike!

DIRECTOR GENERAL MCADOO'S MESSAGE

"The strike of certain shopmen, machinists, etc., in the railroad shops at Alexandria, Va., has created a very painful impression on the public mind. I cannot believe that these men knew what they were doing. They are all employees now of the United States government. They are not employees of any railroad corporation, therefore this was a strike against the government of the United States. It is the first time in the history of our government that any of its employees have attempted a strike against their government. Such action is incredible. For the good of our beloved country and for the honor of railroad men in the service everywhere I hope that there will be no repetition of what everyone must condemn as unpatriotic in the highest degree.

"The government cannot, of course, be coerced or intimidated by any of its employees. It is anxious to do justice to all and will do justice to all as far as it is possible to measure justice. Recognizing that there are probable inequalities in the recommendations of the Wage Commission

which should be impartially considered and dealt with, I appointed in my General Order No. 27, dated May 25, a board of railroad wages and working conditions composed of three representative labor men and three representative railroad men, whose duty it is to hear and to pass upon all petitions and complaints. Every class of employees or parts of classes of employees who feel that they have just ground for complaint under the wage decision should submit their cases promptly to this board and they will be given just and impartial consideration. The American people have just been called upon to pay largely increased freight and passenger rates for the purpose of paying in part the increased wages, amounting to more than three hundred million dollars, awarded to railroad employees.

"Suppose they should strike against the government because they do not think they are fairly treated in being forced to pay these increases for the benefit of railroad labor, what would happen to our country? Suppose that railroad officers should strike because they dislike the orders of the government and should refuse to obey them, what would happen to them? Suppose that railroad employees should strike against the decisions of their government and hamper the operation of the railroads at a time when transportation is essential to protect the hundreds of thousands of American boys now fighting on the battle fields of Europe to save the lives and property and liberty of railroad employees serving here at home, what would happen to our country?

"The Kaiser would probably get it. We cannot all get exactly what we want in this world, nor can we win this war unless each and every citizen is willing to submit to the laws of the land and to the decisions of those in authority.

"We railroad men particularly must give unswerving and loyal support to our government, no matter what our individual views and disappointments may be, relying upon a fair hearing of our complaints and the justice of our cause and accepting patriotically the final decisions of those in authority who, under our laws, are charged with the responsibility of making them.

"While in the German drive now going on the sons of railroad men and the sons of Americans of every class are dying on the battle fields of France to save America and democracy in the world, shall there be found among us any man or set of men who are unwilling to sacrifice something of their personal views and individual desires to support America's heroes who are making the supreme sacrifice for us? I earnestly hope that from one end of this great land to the other it may never be said again that any railroad man, officer or employee, was so unpatriotic as to strike against his own government when it is in the midst of the most perilous war of all history. It is the highest duty of patriotic men to remain at their posts with the railroads, where they are so urgently needed for the safety of the country, and to rely upon the board of railroad wages and working conditions and the director general for the just consideration of their claims. I am sure that I can count upon you to immediately urge upon your men by wire the wisdom and patriotism of the course I have suggested."

LABOR REPRESENTATIVES MAKE DEMANDS

On June 3 representatives of 500,000 railway shop men appeared before the Board of Railroad Wages and Working Conditions with a request for a minimum wage of 75 cents an hour for machinists, blacksmiths, sheet metal workers, electricians and car men with four years or more experience, and boilermakers, and a minimum of 56¼ cents for car men with less than four years experience. The eight-hour standard day was requested, six days work a week and time and a half for overtime; these demands representing an increase of about 40 per cent above existing wages.

Director General McAdoo later issued General Order No. 29 creating a commission to be known as Railway Board of Adjustment No. 2 to consist of 12 members, six to be selected by the regional directors and one each by the chief executive officer of the Railway Employees' Department of the American Federation of Labor; the International Association of Machinists; the International Brotherhood of Boilermakers, Iron Shipbuilders and Helpers of America; the International Brotherhood of Blacksmiths and Helpers; the Brotherhood of Railway Carmen; the Amalgamated Sheet Metal Workers' International Alliance, and the International Brotherhood of Electrical Workers. This board will adjust all controversies growing out of the interpretation or application of the provisions of wage schedules or agreements which are not promptly adjusted by the officials and employees of the roads operated by the government.

THE RAILWAY INDUSTRIAL ARMY*

BY W. S. CARTER

We are told by those who know that it requires four tons of shipping to maintain one American soldier in France. We are told by those who are determined to win the war that by the spring campaign of 1919 we will have more than two millions of our boys "over there," and as the war progresses more and more ships will be required to transport across sea food and munitions with which to maintain our fighting force. Not only the winning of the war depends upon this ceaseless flow from our farms and our factories to the battle front, but, without it, the men we send to France in freedom's cause will be sacrificed.

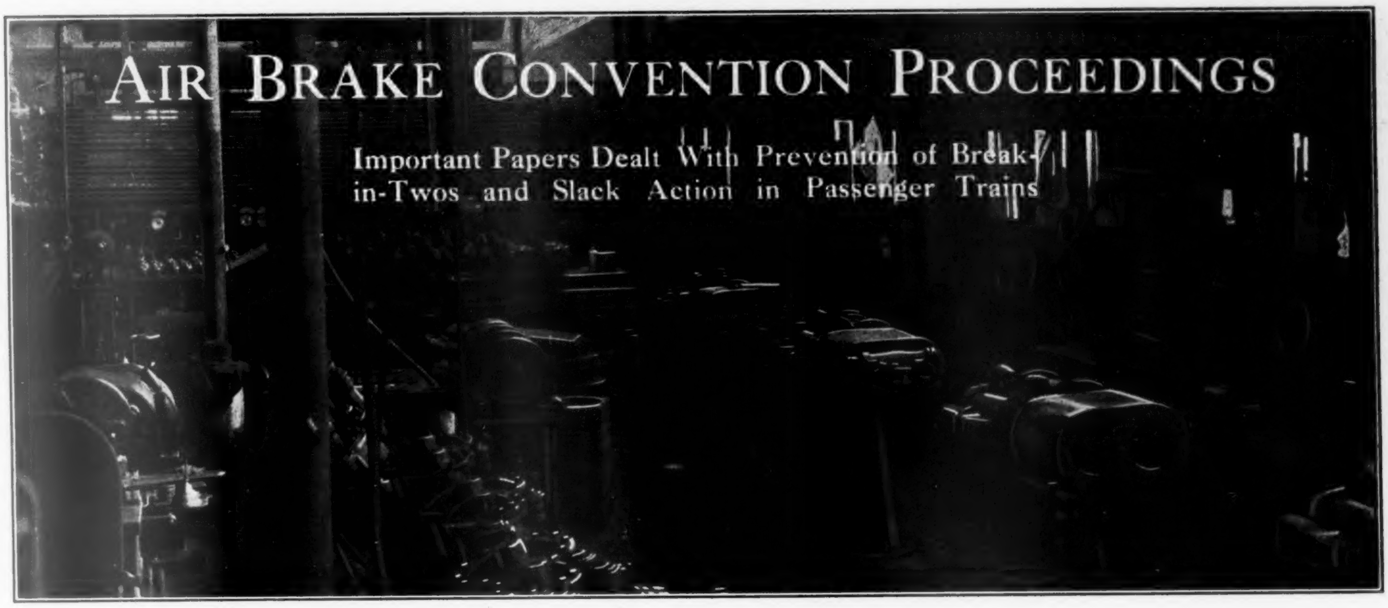
When we talk of this stupendous movement of war supplies we seem to think only of ships, but little thought is given to the fact that upon our railroads these ships must depend for cargoes and bunker coal. The reason that we have not more fully recognized this fact is because heretofore the capacity of our railroads has exceeded that of our ships. We read from day to day of the splendid developments of the shipbuilding industry, and the day is not distant when our ports will be crowded with ships in readiness to perform their part in this great transportation problem. When that day comes we railroad men will have a rude awakening. No longer may we conduct our business affairs and maintain our conditions of labor as in the days of peace.

Without yielding their laudable purpose to limit a day's work to eight hours when this war is over, the American working people must now work as long each day as the war's necessities demand, compatible with their physical well-being. So long as brothers and sons of American working people are dying in France for our liberty none of us will hesitate short of our greatest effort. Business men must no longer profit out of our country's misfortunes. Great wealth accumulated during this war will not be the product of patriotism. With millions of men now under arms in France, with thousands of ships ready for cargoes and bunker coal, railroad men will soon realize that truly they are a component part of the American expeditionary forces. In fact, they are now a great industrial army. Their failure to maintain an efficient line of transportation will cause ships to lie idle in our harbors and deprive our battle line of munitions and food.

A breakdown in the efficiency of our railroads here when the crisis comes will be no less disastrous than a rout of one of our armies in the great battles that must be fought before the war is won. I shall not attempt to tell each railroad man what he should do to avert the possible collapse of our transportation system when it is put to a crucial test. Each and every railroad man's conscience will tell him that.

I know that the railroad employes of this country will not be lacking in the performance of their duty to the nation and to those who go across the sea to win or die.

*Abstract of a paper presented at the recent convention of the International Railway Fuel Association.



Air Brake Convention Proceedings

Important Papers Dealt With Prevention of Break-in-Twos and Slack Action in Passenger Trains

SAFETY of train operation and economy in the maintenance of brake equipment to meet war time conditions were the key notes of the twenty-fifth annual convention of the Air Brake Association. The meeting was held at the Hotel Winton, Cleveland, O., on May 7 to 9, 1918. Over 200 members attended. Morning and afternoon sessions were held and all amusement features were eliminated so that all the papers might be presented in two days.

The president, C. H. Weaver, supervisor of air brakes of the New York Central Lines west of Buffalo, in opening the convention, spoke in part as follows:

PRESIDENT'S ADDRESS

At this unusual time, when cars and locomotives are in such great demand and transportation pressure is severe, there is naturally a tendency to slight air brake tests and repair work. This is a grave error. At no time in the history of our association can the air brake man be of such vital importance to his company as at the present period, by seeing that all air brake work is properly performed and no material wasted. Work slighted or improperly done causes failures, which mean delays to traffic and even disaster.

I would suggest that the various air brake clubs throughout the country have their secretaries get in touch with the secretary of the Air Brake Association, to the end that there may be a perfect co-operation between these various organizations and our association. In this way many subjects may be taken up by the clubs and threshed out before being presented to the association.

MR. MACBAIN'S ADDRESS

During the opening session of the convention, D. R. MacBain, superintendent of motive power of the New York Central Lines west, addressed the association. A brief abstract of his address is given below.

A question that is more important than any other thing confronting us at the present time is the maintenance of the air brake equipment on freight cars. The maintenance of the piping, cylinders, connections, etc., on freight car equipment in this country has been given much less than the desired amount of attention, and while we have started along the right line toward improvement, we are not yet to that point of efficiency in the matter of maintenance that is desirable for the proper handling of the freight trains of the present day. This is the field wherein the greatest improvement can be made by this association and its members, scattered all over the country as they are. A concerted campaign in the matter of proper piping maintenance, cylinder and triple valve cleaning and slack adjusting will bring such satisfactory results as to warrant any expenditure that may be necessary to that end.

SLACK ACTION IN LONG PASSENGER TRAINS

Slack action shocks may be produced by (a) shutting off the engine-throttle quickly and applying the engine and train brakes somewhat heavily; (b) applying the engine brakes and then the train brakes; (c) trains with brake conditions that produce effective braking power on the engine and head cars in advance of the rear cars; (d) cars in a train having a lower percentage of braking power than the balance of cars, which may be due to their being loaded in one case and empty in another; (e) inability to produce a low-brake cylinder pressure in the beginning of a brake application.

The severity of any shock produced from the above will depend upon the degree in which any of the above mentioned features exist, the number and weight of cars, rate of speed, and amount and rate of producing brake cylinder pressure. Even though all the above conditions do exist, with the exception of (e), if the engineer so manipulates the brake that light brake cylinder pressure will be obtained when the brake application is first started, any slack action that does occur will, of course, occur slowly, and will not be noticeable in the form of shocks. On the other hand, if it is impossible for the engineer to control the brake cylinder pressure in the beginning of the brake application, to provide for a slow movement of the slack in the train, it is necessary to so modify the other features that the handling by the engineer will produce satisfactory results.

Where slack action occurs with uniform piston travel, and shocks are produced during brake applications, it may be brought about by the brakes in one end of the train applying effectively in advance of the brakes on the other end, or by great differences in the percentage of braking power on different cars throughout the train.

Increasing the percentage of braking power on the locomotive and also on the load carrying cars might prevent the slack running out in the form of jerks, but at very low speeds it would increase the tendency for a collision between the head end and rear end of the train unless provision was made to apply the brake so slowly that the slack action would not be noticeable.

Where conditions are such that heavy brake applications

produce unsatisfactory results, it is the practice to slightly increase the time in which the stop is made, by graduating the brake on through light reductions when the application is first started; instead of attempting a stop in thirty-five to forty-five seconds, the time is increased to about sixty seconds. This provides ample time to avoid any noticeable slack action.

A form of foundation brake gear can be employed which will permit of a longer piston travel than is common with the single shoe type if the truck construction is such as to permit of its application. This can be depended upon, with automatic slack adjusters, to maintain the piston travel at practically eight inches without greatly increasing the running piston travel over the standing piston travel, thus insuring a low brake cylinder pressure in the beginning of brake applications, regardless of the speed at which the train is running.

With the single shoe type of foundation brake gear the piston travel may be five inches with 60 lb. in the brake cylinder. When the car is running at a high rate of speed, 60 lb. brake cylinder pressure increases the piston travel to eight inches. At a rate of speed from six to eight miles per hour, a 10-lb. brake pipe reduction may not produce more than four inches piston travel, and the cylinder pressure obtained for this reduction will be from 30 to 35 lb., or twice as much as should be obtained if the piston moved out to eight inches. Under such conditions it is necessary to provide an increased brake cylinder volume in order to permit of a low brake cylinder pressure being obtained in the beginning of brake applications; or to reduce the auxiliary reservoir volume so that the proportion of the auxiliary reservoir and brake cylinder will be such that a low brake cylinder pressure will be possible.

If it is necessary to maintain the same stopping distance, provision must be made to augment the auxiliary reservoir volume so that after the brake application advances sufficiently to provide for the movement of the slack in the train, a higher cylinder pressure, or a higher rate of brake cylinder build-up must be provided for, in order that the final braking power will be sufficient.

If it is necessary to provide short stopping distances for low speeds, when the cylinder volume and reservoir volume are out of proportion, simultaneous application of the brakes throughout the train must be provided for.

If it is impossible to maintain the piston travel sufficiently long to provide for brake flexibility and brake shoe clearance, on account of the action of automatic slack adjusters, it would be necessary to move the slack adjuster connection towards the non-pressure brake cylinder head to provide the desired increased travel. Where excessive false piston travel interferes with the maintenance of the desired piston travel it would be necessary to provide additional movement for the brake piston before striking the non-pressure cylinder head.

If existing types of brake operating equipment are to be maintained intact, the foundation brake gear must of necessity be modified, and any change should contemplate a brake gear that will provide the minimum amount of false piston travel.

Taking into consideration the present conditions with regard to brake equipment, it is necessary that instead of applying the brakes to their maximum in one continuous reduction, the reduction should be made so that the brake application will be gradually produced. Enginemen cannot generally be depended upon properly to carry out instructions with reference to brake manipulation, and the brake application should be automatically timed so that the engineer is able to build up the brake cylinder pressure, or the braking power, at a fixed rate to some predetermined point in the application, and that this rate be dependent upon the operating conditions obtaining on each railroad. Modifying the service brake by increasing the brake cylinder volume or by reducing the reservoir volume can be compensated for by increasing the brake pipe pressure.

Where the single shoe type of foundation brake gear is in common use, and it is the practice to run the piston travel short, necessary shoe clearance is not obtained, with the result that a great many brake shoes are rubbing the wheels hard when the brakes are released. This increases the difficulty of starting the trains over what would obtain if ample shoe clearance was provided on all cars. Increasing the piston travel to provide more flexibility for the service brake, automatically increases the shoe clearance with a consequent reduction in slack action and in the power necessary to start and propel the train. Increasing the piston travel also automatically reduces the difficulty of releasing brakes, because it necessitates slightly heavier applications to produce effective braking power. Heavier applications of the brakes tend to insure against the difficulty in starting trains which arises when stops have been made from low speeds with light brake applications.

At the Atlanta convention an attempt was made to draw a distinction between inherent and contingent limitations in brake equipment for passenger service. It will be agreed that maintenance and manipulation are contingent limitations, and that each should be kept up to the highest order of efficiency. But it is our duty to recognize and extend the fundamental limitations to obtaining the train operation we should have. It only remains, therefore, that those concerned give the matter sufficient consideration to evolve from the principles here suggested an equipment which will produce satisfactory results.

The report was signed by G. H. Wood, chairman; H. L. Sandhas, M. E. Hamilton, Mark Purcell, H. F. Wood, L. S. Ayer, T. F. Lyons, L. P. Streeter, M. S. Belk, W. J. Hatch, C. H. Rawlings, J. A. Burke, R. C. Burns and Wm. Spence.

DISCUSSION

In the discussion of the report it was brought out that the Santa Fe had reduced break-in-twos to seven or eight last winter from a total of 75 to 100 during the preceding winter, by making changes in the brakes along the lines suggested in the report. An expedient not mentioned in the paper, which has been adopted on some roads for preventing excessive shocks from the slack run-in on long passenger trains, is the application of the brakes before closing the throttle. This practice has met with considerable success, in that it prevents the too rapid retardation of the locomotive and front end of the train, thereby reducing the velocity difference between the cars in different parts of the train during the time required to build up braking power throughout the length of the train.

Walter V. Turner called attention to the facts that the initial brake pipe reduction in the application of the brakes should never be less than seven pounds. Less than this will not insure the application of all the brakes in the train, some applying and some failing to apply. In case the initial reduction is not followed up with an additional reduction before releasing, some of the brakes which are applied are apt to fail to release, unless a reduction of seven pounds or over has been made. Mr. Turner advocated the testing of the brakes with 15 lb. in the cylinders and the adjustment of the piston travel to seven inches, rather than with a pressure of 60 lb. and eight inches piston travel. He pointed out that it is not with the maximum pressures that the damage is done, but with the low cylinder pressures which, owing to improper piston travel, may be two or three times as high as they should be. If a piston travel of seven inches is secured with 15 lb. in the brake cylinder, it will be im-

possible for the engineer to damage the train through lack of extraordinary skill in manipulation.

THE SAFE LIFE OF AN AIR BRAKE HOSE

At the 1917 convention the committee was instructed to continue their investigation for another year. For the 1918 report matter of porous hose has been considered. Records were obtained of 25,000 air hose in service. These were inspected in five different groups, and data in regard to them is given in Table I.

TABLE I—RECORD OF INSPECTION OF 25,000 AIR HOSE

Group No.	No. hose inspected	No. found porous	Per cent hose porous	Average life of porous hose in months
1	899	93	10.37	26.3
2	8,000	728	9.1	32.9
3	5,026	224	4.0	26.5
4	6,000	2,806	46.0	28.5
5	5,075	1,215	20.2	29.3
Totals and average	25,000	5,066	18.1	28.7

As was found last year, the average life of the air hose still in service was considerably less than that of those which were found burst or porous, this being due to the fact that hose inspected did not burst until they were in service an average of 28½ months, and might reasonably be expected to burst at any time after that length of service. Comparing the average life of the porous hose with the average life of burst hose as inspected last year, there is only a difference of two-tenths of a month.

Every member is well aware of the detrimental effect of brake pipe leakage, but it is possible that due weight may not be given to the effect a few porous hose in a train may have. One of the committee caused five trains to be tested for leakage, inspected for porous hose, and again tested for leakage, after the porous hose had been removed. The train in each case consisted of 65 cars, and therefore, represented 132 hose, exclusive of those between the engine and tender. The results obtained from these tests were as shown in Table II.

TABLE II—EFFECT OF POROUS HOSE ON TRAIN PIPE LEAKAGE

Train No.	Leakage per minute before testing for porous hose	No. hose found porous	Leakage per minute after removing porous hose
1	15 lbs.	6	7 lbs.
2	18 lbs.	5	8 lbs.
3	20 lbs.	8	6 lbs.
4	12 lbs.	6	6 lbs.
5	14 lbs.	7	7 lbs.

C. H. Weaver (N. Y. C.)
President

F. J. Barry (N. Y. O. & W.)
Vice-President

C. W. Martin (P. R. R.)
Vice-President

F. M. Nellis (Westinghouse Air Brake Co.), Secretary

Otto Best (Nathan Mfg. Co.)
Treasurer

It is evident that a vast improvement was brought about by inspecting these trains for and removing porous hose, and yet the average number found porous in five trains was only 4.85 per cent of the total number of hose in the train. Remembering that of all hose inspected, the general average found porous was about 18 per cent, we may begin to realize the handicap under which our enginemen and inspectors are working and also the outbound terminal delay due to inaudible brake pipe leakage in the porous hose.

The committee recommends that a system of inspection and soap suds tests on repair tracks, at least, for the pur-

pose of detecting and removing from service all porous hose. The benefit to be derived from this was quite noticeable on one railway. It was found that while the percentage of porous hose ran very high at the beginning, it gradually lessened until within two months, it was reduced to such a point that only 2 per cent of the hose tested were found porous. It was also noticed that outbound terminal air brake delays decreased.

In order to lengthen the life of air brake hose and reduce hose expense the railroads must do one of three things: either put into effect a rule which will cause the hose to be parted by hand, buy a guaranteed hose from the manufacturer, or take up the use of properly constructed braided hose. The two latter items slightly increase the first cost of hose, but reduce the ultimate cost, while for the first item it is an open question whether or not any rule which demands the parting of hose by hand can be universally enforced.

Under present conditions, notwithstanding the fact that some hose have shown a very long term of service, we cannot depend on the average hose remaining in service for a longer period than 28½ months. After that period great numbers of hose are porous and liable to burst under normal pressure at any time.

The report was signed by M. E. Hamilton, chairman; George W. Noland, Joseph W. Walker, M. S. Belk.

DISCUSSION

The principal point brought out in the discussion of this paper was that the most common cause of the destruction of air brake hose is the failure to part the hose by hand before the cars are separated. That the automatic parting of the hose coupling is a severe strain upon the hose is evidenced by the fact that this often results in pulling out or breaking off the train-pipe. The difficulty in overcoming this source of hose destruction lies in the impossibility of enforcing the rule for yardmen and trainmen to part the hose by hand. The only other solution suggested was to put inspectors on to cut all the hose, a practice which is followed in many places. It was suggested that the money spent in this way would be returned many-fold by the reduction in the cost of brake hose renewals and repairs.

The association adopted a motion recommending to the Train Brake and Signal Committee of the Master Car Builders' Association that the safe life of an air brake hose be placed at 28 months.

PREPARING AIR BRAKES AT TERMINALS

Installation.—The brake cylinder and auxiliary reservoir should be bolted to the most rigid portion of the underframe and all points of fastening should be equally rigid to avoid twisting or cramping strains. Air brake piping should be securely clamped to prevent shifting when cars are subjected to shocks. This will avoid many broken or distorted cross-over pipes, loose pipe joints and other causes that produce excessive leakage.

Maintenance.—It is not necessary that the men in charge of air brake maintenance be able to trace the course of the air through all the valves or know the size, location and duty of the ports and passages, but the test rack operator and the men doing the repair work should have sufficient knowledge to tell what effect an ordinary defect will produce.

If the man in charge is to be successful in supervising air brake work he should know, when a triple valve is applied to a car, that it has been properly repaired, cleaned and tested and is suitable for service. A brake tested by making a service application at the proper rate will often fail to apply or remain applied, while if tested by making the reduction at an excessive rate, but less than required to produce an emergency application, the brake will apply and remain applied. Hence, the importance of testing brakes with a service reduction at the proper rate.

There is no economy in re-applying triple valve gaskets that have become hardened, cracked or disfigured so that they are likely to cause leaks, as the extra labor involved in removing them will more than equal the cost of new gaskets.

The application of levers of improper dimensions and proportions cause brake-rigging failures, slid flat wheels, improper and unequal braking power. Changing brake shoes without readjusting the piston travel is often the direct cause of slid flat wheels and break-in-twos. Permitting cars to leave shop or repair tracks without hammering and blowing out the brake pipe is not treating the triple valve on the car or other cars in the train in a manner conducive to good operation. Applying triple valves to cars without first seeing that branch pipe strainers are inserted and in good condition, and failure to clean out dirt collectors at proper intervals causes numerous triple valve troubles.

A brake cylinder cannot be properly cleaned without removing the expander ring. An egg-shaped expander ring applied to a brake cylinder will soon wear packing leather through at the point where it bears heaviest against the cylinder wall. A car which leaves the repair track without having retaining valve and piping tested stands a good chance of being set out for air brake work if required to operate under grade conditions. Testing a retaining valve without ascertaining that both exhaust ports are open is inviting slid flat wheels and brake-burn wheels.

These illustrations of improper repairs, careless testing and poor maintenance convey some idea of the importance and value of a man in charge of maintenance who properly supervises the airbrake work. The fact that a railroad employs an air brake instructor or supervisor to have general charge of the air brake department, does not in any way relieve the man in charge of maintenance of the responsibility of knowing absolutely that the air brake work of the men under his supervision is of the proper character. In the case of the repair man in the car department, this duty falls upon the car foreman. The car foreman should obtain all assistance and instructions possible from the air brake instructor and encourage the men under him to do likewise.

Initial Inspection Test.—Cut in brakes on all cars not carded, and see that all air brake parts and piping, as well as foundation brake rigging, are in place, properly located and in good condition. Care should be taken to examine train pipe for rusted or worn places at the body bolster, for defects or corrosion at the angle cock nipple, and for condition of the retaining pipe at the end sill bend. Brake pipes should then be blown out. The brake system should then be charged to at least 70 lb. and inspected for leakage, to see that pipe clamps are in place and that nuts on bolts holding cylinders and reservoirs are tight. Leaky angle cocks and porous hose should be removed and replaced with hose and angle cocks that have been tested in the air brake room.

Retaining Valve and Brake Cylinder Test.—After making initial inspection, retaining valve handles should be turned up and brakes applied by making a service reduction of 20 lb., not more than five cars being tested at one time. See if all brakes have applied. Release, and one minute after the exhaust at the retaining valve begins brake shoes should still be firmly against the wheels so they cannot be moved with club or foot. Should there be practically no exhaust from the retaining valve when the handle is turned down it indicates a defective retaining valve, leaky retaining pipe or a leaky brake cylinder leather. It must be determined at each inspection that both exhaust ports of retaining valve are not clogged up by paint and dirt; that cock keys are not leaking; that handles are in good order,

and that the retaining valve is properly secured and stands perpendicular.

Brakes that do not apply with a service reduction; that apply quick action with a service reduction; that have leaky brake cylinder packing leathers; that have leaks at exhaust ports of triple valve, or those on system cars that have not been cleaned for eight months and foreign cars that have not been cleaned for twelve months, should have the triple valves removed and replaced with triple valves that have been cleaned and tested in accordance with M. C. B. standard practice, brake cylinders and dirt collectors cleaned, branch pipes blown out, branch pipe strainers cleaned and renewed if not in good condition, cylinders tested and stencilled according to M. C. B. standard practice.

After brakes have been cleaned and assembled, and piston travel adjusted, apply and release the brake several times to set the packing leather out against the wall of the cylinder; then make a 20-lb. brake pipe reduction and make a mark on the piston sleeve ¼-in. from the non-pressure head and note at the expiration of three minutes if the mark is still visible. If not there is excessive brake cylinder leakage which must be located and repaired. Piston travel must be adjusted to between seven in. and 8 in. with a 20-lb. service reduction from an initial brake pipe pressure of at least 70 lb. Any brake shoes must be renewed before the piston travel is adjusted.

The Terminal Test.—No train should be permitted to leave a terminal without a terminal test. The brakes should be fully applied and thoroughly inspected while brakes are applied to note any irregularity that would be liable to produce train shocks and break-in-twos. Trains in transit over large systems of railroads should be tested at each division point and for such test we recommend an incoming brake test. The outgoing freight brake test should be merely a check against error. To then set out defective brakes for repairs is to disorganize despatching and switching, thus delaying cars ready to proceed and greatly augmenting expenses.

Incoming Freight Brake Terminal Test.—Enginemen and trainmen on arrival at the terminal will leave the brakes applied by a 20-lb. service reduction made from 70 lb. On its completion he will give one short whistle blast as advice to brakeman that he may cut off and to inspectors that inspection may begin. The brakeman will not close angle cocks until this signal is given.

On brakes being applied inspectors will rapidly examine for pistol travel, brakes failing to apply, any that have leaked off and brake pipe leaks, indicating the defects with chalk. After completing the inspection, repair the defects that should be cared for in the yard. For other defects bad-order the cars for repair tracks unless impracticable, as may be with perishable or time freight. The air brake and the general inspection must not be combined.

Brake Pipe Leakage.—Excessive brake pipe leakage wastes air, takes away from the engineman the ability to control the amount of brake applications, contributes to brake sticking, causes overheating of the air compressor and even prevents the maintenance of standard brake pipe pressure. Hence, it must be avoided.

Brake pipe leakage is produced in numerous ways, but the most common causes for it are poorly clamped piping that will permit shifting in switch movements or shocks on the road, and allowing train and yard men to pull hose apart instead of separating them by hand, as this produces spread coupling jaws, destroys gaskets and creates porous hose.

Brake cylinder and auxiliary leakage are just as productive of damage to trains as is brake pipe leakage. If a triple valve permits the desired pressure to pass from the auxiliary reservoir to the brake cylinder and then due to a bad leather in the cylinder or defective gasket under the pressure head the pressure is permitted to leak to the atmosphere, the effectiveness of that brake is lost. On the other hand, if we have a leaky auxiliary, either from a carelessly applied drain plug or a poorly fitting exhaust valve or a slide valve leaking, then after an application the auxiliary pressure leaks down until two or three lb. below the brake pipe pressure when the brake will release.

Other factors that assist in producing leakage are brake pipes applied out of proper height and distance from the face of the coupler; nipple ends broken off and new threads cut on old nipples, shortening the brake pipe, and angle cocks applied and not given the proper angle toward center of track.

Defective Triple Valves.—With the brake pipe and auxiliary fully charged trainmen, in separating the train, often close only the angle cock on the portion of train to be moved and then pull the brake hose apart, setting all the brakes in emergency on the standing portion of the train. Repeatedly applying brakes in emergency in this manner is frequently the cause of triple valves becoming defective on account of bent emergency piston stems. The only remedy is to remove and repair them.

Undesired quick action can be caused by permitting triple valves to become dirty and gummy to the extent that the piston sticks and requires a high differential to cause a movement. It can also be caused, especially with long trains, by a very light brake application or a very slow reduction where it would be avoided by braking according to proper methods.

How Train Shocks May Be Eliminated.—To prevent damaging shocks in long trains braking power must be as near uniform as possible on all cars, and that loaded and empty cars be so distributed that the greater part of each will not be at the head end or rear end of trains.

Long piston travel is preferable to short piston travel, because the cylinder pressure will be built up more slowly and consequently any movement of slack in the train will take place proportionately slower, with a reduction in the velocity difference between cars. While there will be a considerable difference in the cylinder pressure between a five-in. and seven-in. travel at the beginning of a brake application, the pressures will be nearly equal when the brake is fully applied. If the piston travel is short, say five in., it is possible to develop a high brake cylinder pressure (45 lb.) at the head end with a 10 lb. reduction before the beginning of brake application at the rear. This causes the slack to run in from the rear, sometimes with very damaging results if the speed is low. If the piston travel is long, say eight or nine in. standing travel, it is possible to make the same reduction and only produce 20 to 25 lb. cylinder pressure, less than one-half the pressure produced with the short piston travel. This reduces the rate of retardation set up on the head end of the train, and consequently the severity of any slack action due to a run-in of the slack.

Excessive Draw Bar Slack.—Another liberal contributor to train shocks and break-in-twos is excessive draw bar slack. The inspector should be instructed to watch this feature closely and make every effort to have cars with undue draw bar slack sent to the repair tracks in order that this may be corrected.

With no slack and good draft rigging, trains could not be broken in two. The same can be said with slack either all in or all out and held so. The damage arises from its sudden change. When slack runs in or out rapidly one part of the train gradually attains a lower speed than the other and the shock is the result of the draft rigging having to suddenly make the speed uniform on the instant the slack is all in or out. How heavy the shock will be depends mainly on the difference in speed that must instantly be made uniform and on the weight that must suddenly be altered in speed. Weight is important, but change in speed

is more so, as changing it suddenly three miles per hour will cause nine times the shock than will a similar quick change of one mile per hour.

The report was signed by E. Hartenstein, chairman; O. H. Bradbury and John Foster.

DISCUSSION

Among the points emphasized in the discussion of this report was the necessity for setting the brakes with a full application on incoming trains and the stretching test, in order that the condition of the brakes may be observed and the necessary repairs made during the time that the cars are in the terminal rather than after the outgoing trains have been made up and are ready to depart, and also for the purpose of inspecting worn knuckles and abnormal slack in the draft gear. The need for greater co-operation on the part of enginemen and trainmen in making these tests was brought out. It is often observed that the angle cocks between the locomotive and train are closed even before the train has been brought to a full stop. The practice of inspecting and cleaning brake cylinders and triple valves on team and house tracks which is now followed by some roads was endorsed. This insures that the brakes on the cars will be in good condition when they are made up into trains and that they will remain in the trains until they reach their destination. As a means of maintaining a reasonably constant piston travel with a minimum amount of labor, it was suggested that care be exercised at shops and repair tracks to see that brake shoes on a car are not of uniform thickness, but vary considerably between the limits of a new shoe and one ready to scrap. The ideal condition would be to have one new shoe, with a maximum wearing thickness of about 1 in., and the other shoes ranging in thickness in successive steps of 1/8-in. wear, the thinnest one being within 1/8 in. of the scrapping limit. Under this ideal condition the shoes would be renewed successively one at a time at intervals of 1/8-in. wear, with a correspondingly small variation in the piston travel from the desired amount for which the brake rigging was adjusted.

The association adopted a motion recommending to the Master Car Builders' Association that Rule 6 be supplemented by a provision permitting all roads to clean brake cylinders and triple valves on foreign cars sent to the repair track for other defects, nine months after the previous cleaning.

OTHER BUSINESS

Reports were also submitted on the cross-compound air compressor; on the maintenance and operation of the feed valve, outlining the practice on the Canadian Northern, of concentrating the repairing of feed valves at a few points where competent labor may be maintained, and a specialized system of repairs for which a complete set of gages, special reamers, etc., has been developed; on M. C. B. freight brake stencilling, and on proposed changes in the recommended practice of the association. The stencilling report recommended that when either the triple valve or the brake cylinder must be cleaned, lubricated and tested, all other parts, including the retaining valve and the dirt collector, be cared for at the same time, and that any other repairs needed by the brake equipment be made then. It was suggested that this practice would save time and money, and would insure getting more service from cars than is obtained with the present practice of stencilling and maintaining each part separately at different times. This recommendation was adopted by the association to be presented to the Train Brake and Signal Committee of the M. C. B. Association.

The conservation of material and supplies was discussed at Wednesday's session, and the topic was assigned as the subject of a committee report to be prepared from the data presented by the members during the discussion and from a more complete survey of the possibilities of conservation of air brake materials.

In addition to speeches by C. H. Weaver and D. R. MacBain, short addresses were given at the opening session by W. O. Thompson of the New York Central Lines; Martin Beman, director of Public Welfare of the city of Cleveland, and W. S. Stone of the Brotherhood of Locomotive Engineers. On Wednesday evening Walter V. Turner gave a lecture on freak inventions.

The treasurer reported the largest balance that the association has ever had in its treasury, and the executive committee voted to invest $1,000 in War Saving Certificates. The secretary advised that the membership was now over 1,000. The officers elected were as follows: President F. J. Barry, New York, Ontario & Western; first vice-president, T. F. Lyons, New York Central; second vice-president, L. P. Streeter, Illinois Central; secretary, F. M. Nellis, Westinghouse Air Brake Company; treasurer, Otto Best, Nathan Manufacturing Company.

THE POOR LITTLE RICH BILL

BY GLADYS SCHUSTER

"Who are you?" our editor said yesterday, when a sick looking stranger appeared before him. "You look a bit familiar, although I'm sure I haven't seen you for some time."

"I'm A. Dollar Bill," the stranger weakly answered.

"Oh—pleased to recognize you, Dollar Bill," cordially beamed our editor, holding out his hand. "You look a bit weak, old friend. What's the matter?"

"I'm not the same Bill I used to be," mournfully said the visitor. "I can only do about half the work I used to do before the war."

"Pretty tough," our editor reflected. "Have you been to see the doctor?"

"I went to see Dr. McAdoo," answered Bill, "and he told me that I'll never get my strength back until after the war. He said I ought to gain at least 25c. or 30c. in weight then. In the meantime, he said, I ought to have a rest, and my owner ought to lay me aside against the day when I will be worth more."

"That isn't a bad idea," observed our editor.

"I know," continued Bill, "that some of us Bills must go for food and clothing, no matter how weak we get. But there are lots of us that are going for luxuries and things that our owners don't really need. The fast times are killing us. I thought, if I called it to your attention you might say a word for us. Dr. McAdoo said a dose of publicity would help me. Now, of course, I don't want people to put me in a sock or behind the clock case until the Huns are defeated. My value will increase by investing me in absolute safety."

"How, for instance?" asked our editor, sympathetically.

"If you take four of us and add 17c. to us this month, making $4.17 in all, you can buy a War Savings Stamp from Uncle Sam that will make me worth exactly $5 cash to you on January 1, 1923, and worth even more when you consider how much more $5 will buy then than now. There is nothing imaginary or theoretical about it, either. We Dollar Bills are valuable only because we can buy things people want. I am more valuable when I can buy more of those things than when I can buy less of them. And Uncle Sam will gain while you gain. He will have the use of your money when he sorely needs it, and, believe me, he needs it. And I, Mr. Dollar Bill, will have the patriotic feeling that we have worked together for victory."

"Bill, you know what you are talking about!" exclaimed our editor. "Everybody ought to follow your advice."

2-10-2 Type Locomotives for the U. P.

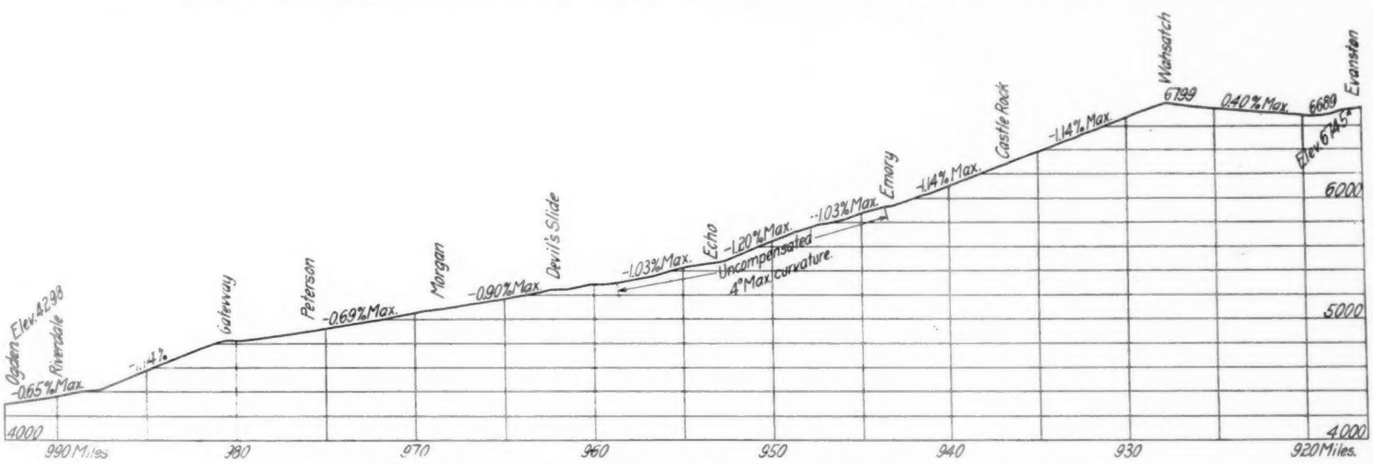
Built for Service on Heavy Grade Division. Road Tests Show Unusually Low Weight per Horse Power

SEVERAL months ago the Union Pacific received from the Baldwin Locomotive Works 15 locomotives of the 2-10-2 type. These were part of an order of 27 locomotives, the others being placed in service on the Los Angeles and Salt Lake and the Utah railway. The locomotives were designed under the supervision of C. E. Fuller, superintendent motive power and machinery and A. H. Fetters, mechanical engineer, and were built particularly for use between Ogden, Utah, and Evanston, Wyo. This division has long heavy grades, the maximum grade being 1.20 per cent with a 4 degree curve, uncompensated, which is equivalent to a grade of 1.36 per cent on straight track. Reconstruction work is now in progress on this division and all grades are being reduced to 1.14 per cent, compensated for curvature. The principal object which was kept in mind in designing the 2-10-2 type locomotives was to make them capable of handling the same train over the reconstructed line between Ogden and Evanston, that the Mikado type locomotives haul on the line east of Evanston, where for 400 miles the maximum grade is .81 per cent.

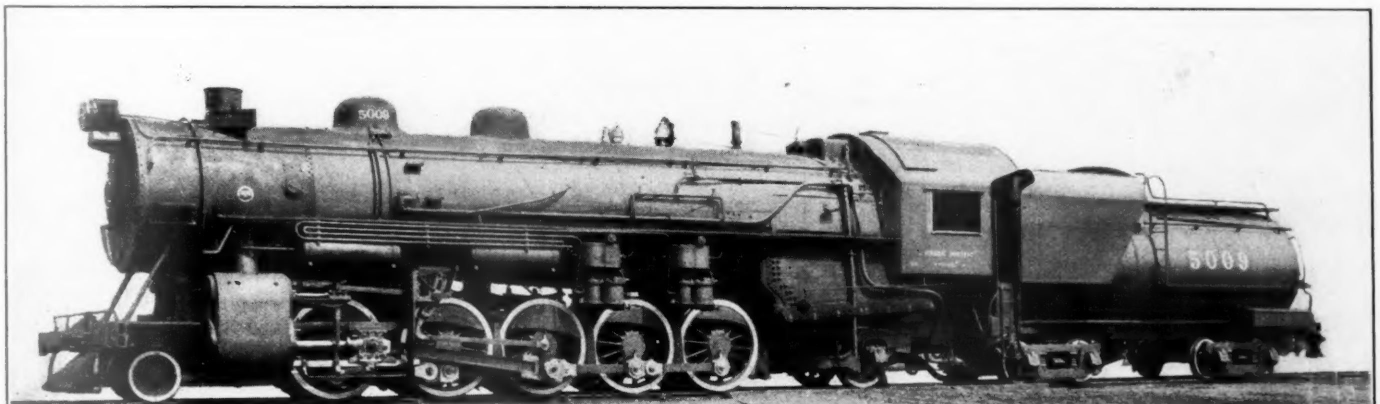
The 2-10-2 type locomotives have a rated tractive effort of 70,450 lb. with 285,500 lb. on the driving-wheels, the ratio of adhesion being 4.05. The total equivalent heating surface is 7,045 square feet or 1 square foot for each 10 lb. of tractive effort. This ratio indicates ample steaming capacity for the heavy class of freight service in which these engines are used.

The boiler is of the straight-top type with a wide, deep firebox placed back of the drivers and over the rear truck. A combustion chamber four feet long extends forward into the boiler barrel, and the tubes have a length of 22 ft. The middle barrel ring has a slope on the bottom to provide a sufficiently deep water space under the combustion chamber. All seams in the firebox and combustion chamber are welded with the exception of that uniting the back sheet with the crown sheet and side sheets. The seam around the firedoor opening is also welded. Flexible staybolts are used in the breaking zone and in the six front rows of stays over the combustion chamber. At the point where the three upper rows of flexible stays on each side pass through the boiler barrel, bosses are welded to the sheet in order to provide a sufficient number of threads for the staybolt sleeves. Both the coal burning and oil burning locomotives are equipped with Security sectional arches and the coal burners are fired by Street type "C" stokers. The superheater consists of 45 elements and has a superheating surface of 1,262 square ft.

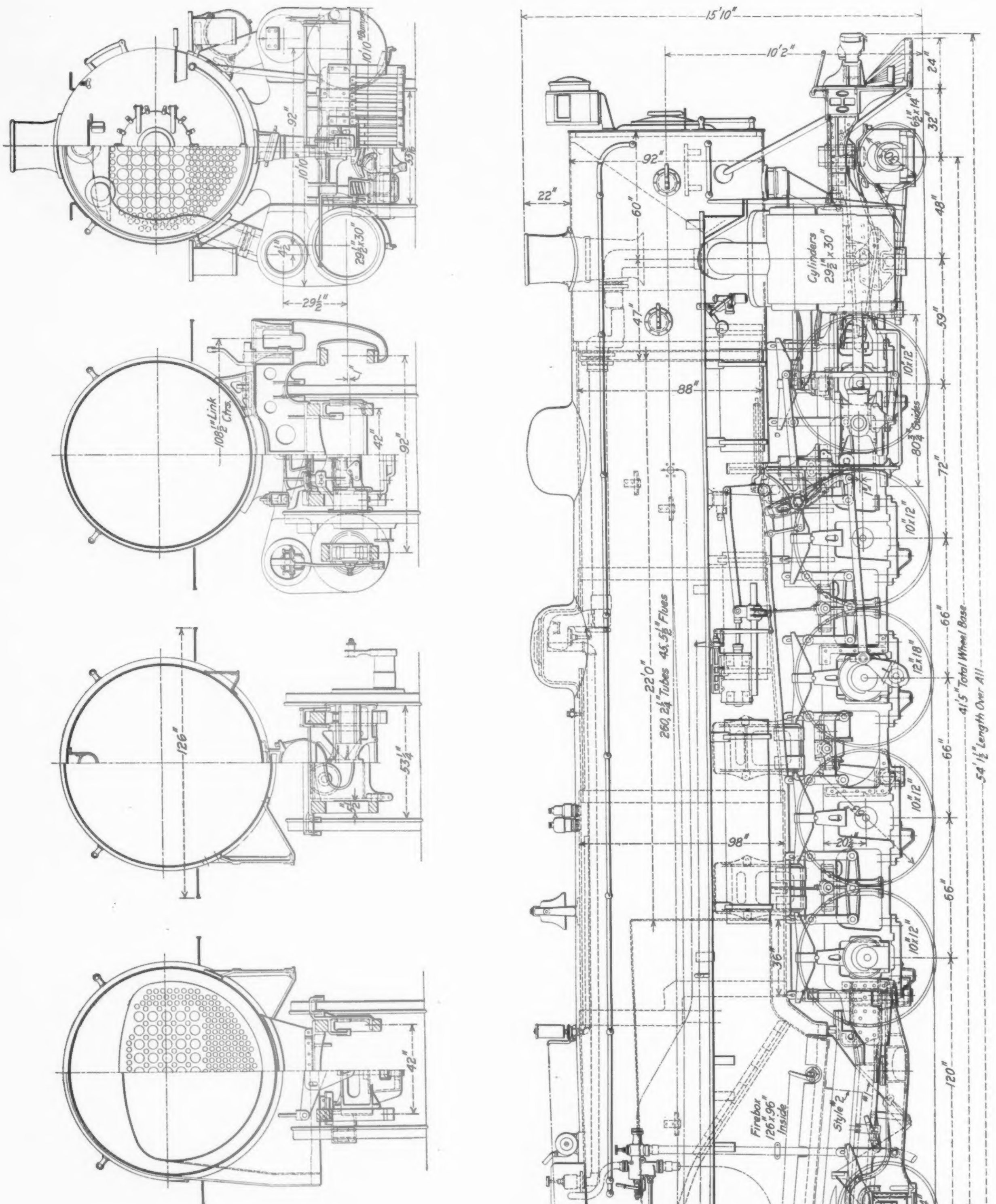
The piston valves are 15 in. in diameter and are driven by Walschaert valve gear which is controlled by a Ragonnet power reverse gear having both air and steam connection. The piston heads, a drawing of which is shown below, are



Profile of the Union Pacific Between Ogden, Utah, and Evanston, Wyoming



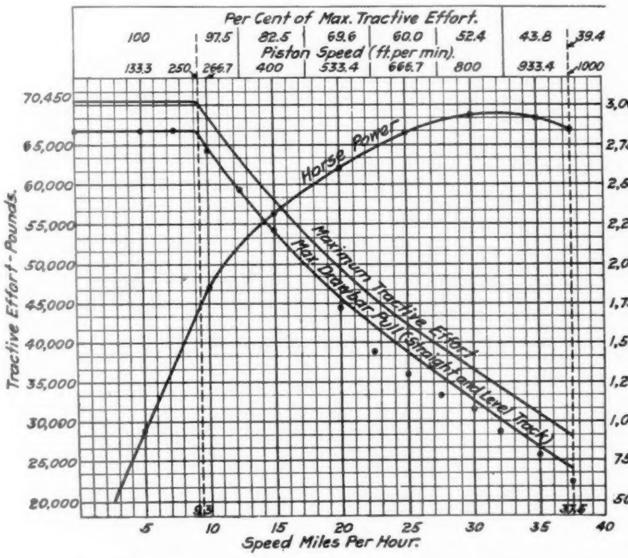
Heavy Freight Locomotive for the Union Pacific Which Develops 2,950 Horsepower



Elevation and Cross Sections of Union Pacific 2-10-2 Type Locomotive

steel castings of dished section, seven inches wide, with phosphor bronze bearing rings and gun iron packing rings. The phosphor bronze rim is cast on the piston before the grooves for the packing rings are turned. Inspection of these pistons after six months' service showed that they had worn less than ¼ in. The piston rods are of open-hearth steel, heat-treated and hollow-bored. The same material is used for the crank pins and driving and trailing axles which are also hollow-bored. The reciprocating parts are unusually light, the total weight being only 1,925 lb. The dynamic augment of the wheel load at diameter speed does not exceed 48.6 per cent of the weight on the wheel. Long driving boxes are applied to the main axle and lateral motion boxes to the front axle. The latter are used in connection with the Economy constant resistance leading truck.

The frames are annealed vanadium steel castings 5½ in wide and spaced 42 in. between centers. They are braced transversely between adjacent driving wheels and also at the third, fourth and fifth pairs of driving pedestals. The driving box wedges are self-adjusting. The Commonwealth rear frame cradle is applied in combination with the Delta trailing truck, which serves the triple purpose of a frame, radius bar and equalizer. The trailing truck is equalized with the two rear pairs of drivers, the equalization being through a central, vertical, heart-shaped link which is suspended from a transverse beam hung from the rear driving springs. This link acts not only as the equalizer connection but also as the rear truck radius bar pin. It is circular in section at its lower end, and is guided in the frame cradle casting. The bearing between the equalizer frame of the truck and the locomotive frame is made with a spherical surface to provide sufficient flexibility.



Test Results Secured with 2-10-2 Type Locomotive on the Union Pacific

The driving brake system is divided between the third and fourth pairs of wheels. The rear cylinders are placed in a horizontal position back of the main pair of wheels, while the front cylinders are placed vertically and are bolted to the cylinder saddle casting. The arrangement is such that all shoes bear on the backs of their respective wheels. The tender is carried on forged steel wheels, and is of the Vanderbilt type, with equalized trucks and one piece cast steel frame.

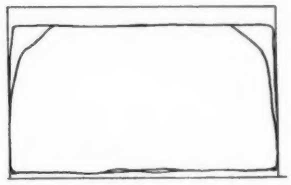
RESULTS OF ROAD TESTS

The Union Pacific has conducted road tests of locomotives of many different types and classes. From the results of these tests a set of speed factors has been worked out to show the ratio of mean effective pressure to boiler pressure at various piston speeds. These ratios for various types of locomotives are given in Table I.

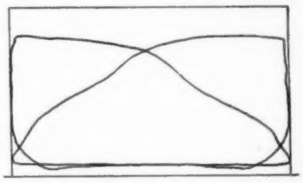
Table I

Piston speed ft. per min.	0 to 250	300	400	500	600	700	800	900	1,000	1,100	1,200	1,300	1,400	1,500
Ratio of M. E. P. to (saturated)	.85	.785	.700	.615	.540	.480	.420	.360	.305	.260	.220	.185	.155	.125
Boiler pressure (superheated)	.85	.785	.700	.615	.542	.495	.445	.390	.335	.295	.255	.220	.190	.160

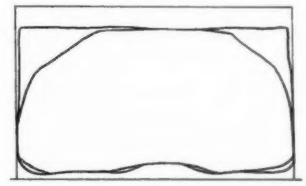
A curve showing the tractive effort of the 2-10-2 type locomotive as calculated from these speed factors will be found in Fig. 1. The maximum drawbar pull on straight and level track is shown by another curve on the same chart.



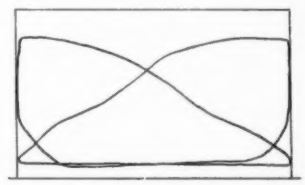
Steam pressure ....200 lb.
Mean effective pres....168.07 lb.
Throttle opening....100 per cent
Reverse lever notch......Corner
Miles per hour.........Starting
Tractive effort ....69,665 lb.



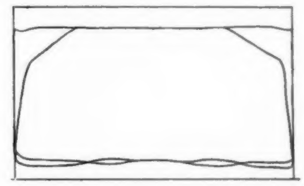
Steam pressure ....198 lb.
Mean effective pres....113.4 lb.
Throttle opening....100 per cent
Reverse lever notch..........6
Miles per hour..............20
Tractive effort ....47,000 lb.



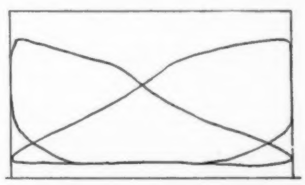
Steam pressure..........200 lb.
Mean effective pressure..160 lb.
Throttle opening...100 per cent
Reverse lever notch..........12
Miles per hour...............5
Tractive effort........66,320 lb.



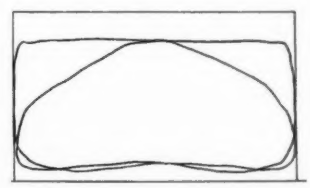
Steam pressure..........197 lb.
Mean effective pres.....93.05 lb.
Throttle opening...100 per cent
Reverse lever notch..........4
Miles per hour..............25
Tractive effort........38,570 lb.



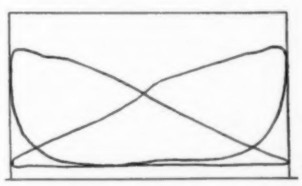
Steam pressure..........200 lb.
Mean effective pres....154.2 lb.
Throttle opening..87.5 per cent
Reverse lever notch..........12
Miles per hour..............10
Tractive effort........63,915 lb.



Steam pressure..........195 lb.
Mean effective pres....84.32 lb.
Throttle opening...100 per cent
Reverse lever notch...........5
Miles per hour..............30
Tractive effort........34,950 lb.



Steam pressure ....196 lb.
Mean effective pres....133.6 lb.
Throttle opening...100 per cent
Reverse lever notch..........10
Miles per hour..............15
Tractive effort........55,380 lb.



Steam pressure..........195 lb.
Mean effective pres....72.4 lb.
Throttle opening ...100 per cent
Reverse lever notch..........4
Miles per hour..............35
Tractive effort ....30,000 lb.

Fig. 2—Representative Indicator Cards, Union Pacific 2-10-2 Type Locomotive

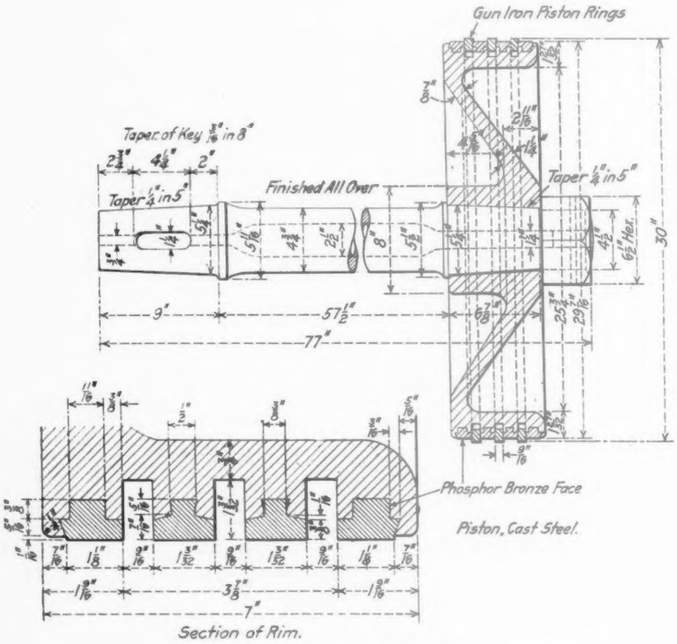
This is obtained from the curve of maximum tractive effort by subtracting 22.2 lb. per ton weight on drivers for machine friction, and 4.5 lb. per ton weight on the leading and trailing trucks and tender trucks, this being an average value for train resistance at low and medium speeds. The points plotted along the drawbar pull curve are values of the drawbar pull recorded by the dynamometer car, corrected for the grade resistance of the locomotive and tender. It is interesting to note how closely the calculated and actual drawbar pulls correspond. At the higher speeds the values found in the test fall below the curve due to the fact that the locomotive was not worked to its full capacity at these speeds. Some of the details of the engine performance are given in Table II.

TABLE II—DETAILS OF ENGINE PERFORMANCE

							Grades		Drawbar pulls (lb.)		
Location	Speed m.p.h.	Reverse lever (notch)	Throttle (opening)	Steam pressure	Maximum tractive effort of engine	Weight of train (tons)	Per cent	Eng. and ten. resistance*	Shown by dynamom'r	Dynamom'r plus engine and tender, grade resistance	Maximum calculated
Castle Rock	Start	Cor.	Full	200	70,450	1,792	1.14	6,085	60,500	66,585	66,820
Leaving Castle Rock	5	12	Full	200	70,450	1,826	1.14	6,085	60,500	66,585	66,820
Leaving Castle Rock	7½	12	Full	200	70,450	1,826	1.14	6,085	60,500	66,585	66,820
Leaving Castle Rock	10	12	Full	200	68,690	1,760	1.14	6,085	57,500	63,585	65,000
Mile Post 933	12½	12	Full	198	63,450	1,760	1.14	6,085	53,500	59,585	59,700
Passing Uintah	15	10	Full	196	58,120	1,826	1.14	6,085	47,500	53,585	54,440
Mile Post 987	20	6	Full	198	49,000	1,760	1.14	6,085	38,000	44,085	45,300
Mile Post 990	22½	6	⅞	200	45,700	1,760	0.65	3,470	35,000	38,470	41,900
Mile Post 987	25	4	Full	200	42,270	1,760	0.68	3,660	32,500	36,130	38,490
Mile Post 988	27½	7	Full	200	39,450	1,780	0.68	3,660	29,500	33,125	35,745
Mile Post 969	30	5	Full	195	36,600	1,746	0.65	3,470	28,000	31,470	32,600
Mile Post 973	32	5	¾	195	34,280	1,746	0.55	2,600	26,000	28,600	30,600
Mile Post 962	35	4	Full	195	30,850	1,746	0.40	2,135	23,500	25,635	26,900
Mile Post 959	37½	3	Full	200	27,760	1,746	0.40	2,135	20,000	22,135	24,265

*Weight of eng. and ten., 267 tons.

The horse power curve is also shown in Fig. 1. A maximum of 2,940 indicated horsepower was developed at a speed of 30 miles an hour. At higher speeds the horsepower decreased somewhat. When working at its greatest capacity this locomotive developed one horsepower for each 121.6 lb. total weight, which is a very creditable performance. Representative indicator cards taken at various speeds are shown in Fig. 2.



Piston and Rod for the U. P. 2-10-2 Type Locomotives

The average tonnage handled on the test trips between Ogden and Evanston was 1,800 gross tons excluding the engine and tender. The average speed while running was 15 miles per hour. The coal used was 2¼ in. screenings from Rock Springs, Wyo. The average amount burned per trip was 48,627 lb., which is at the rate of 9,725 lb. per hour or 115.7 lb. per square foot of grate area per hour. The average coal consumption per 1,000 gross ton miles was 358.4 lb. The average evaporation per trip was 27,283 gallons, the equivalent evaporation per pound of coal being 5.69 lb.

The principal dimensions, weights and ratios follow:

General Data

Gage	4 ft. 8½ in.
Service	Freight
Fuel	Coal or oil
Tractive effort	70,450 lb.
Weight in working order	357,600 lb.
Weight on drivers	285,500 lb.
Weight on leading truck	23,600 lb.
Weight on trailing truck	48,500 lb.
Weight of engine and tender in working order	554,200 lb.
Wheel base, driving	22 ft. 6 in.
Wheel base, total	41 ft. 5 in.
Wheel base, engine and tender	77 ft. 6 in.

Ratios

Weight on drivers ÷ tractive effort	4.05
Total weight ÷ tractive effort	5.08
Tractive effort × diam. drivers ÷ equivalent heating surface*	630
Equivalent heating surface* ÷ grate area	83.9
Firebox heating surface ÷ equivalent heating surface,* per cent	5.37
Weight on drivers ÷ equivalent heating surface*	40.5
Total weight ÷ equivalent heating surface*	50.8
Volume both cylinders	23.73 cu. ft.
Equivalent heating surface* ÷ vol. cylinders	296.9
Grate area ÷ vol. cylinders	3.54

Cylinders

Kind	Simple
Diameter and stroke	29½ in. by 30 in.

Valves

Kind	Piston
Diameter	15 in.
Greatest travel	6½ in.
Outside lap	1¼ in.
Inside clearance	—⅛ in.
Lead in full gear	⅛ in.

Wheels

Driving, diameter over tires	63 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	12 in. by 18 in.
Driving journals, others, diameter and length	10 in. by 12 in.
Engine truck wheels, diameter	30 in.
Engine truck, journals	6½ in. by 14 in.
Trailing truck wheels, diameter	45 in.
Trailing truck, journals	9 in. by 14 in.

Boiler

Style	Straight top
Working pressure	200 lb. per sq. in.
Outside diameter of first ring	88 in.
Firebox, length and width	126 in. by 96 in.
Firebox plates, thickness	Sides, back and crown, ⅜ in.; tube, ½ in.
Firebox, water space	Front, 6 in.; sides and back, 5 in.
Tubes, number and outside diameter	45—5½ in.
Flues, number and outside diameter	260—2¼ in.
Tubes and flues, length	22 ft. 0 in.
Heating surface, tubes and flues	4,774 sq. ft.
Heating surface, firebox, including arch tubes	378 sq. ft.
Heating surface, total	5,152 sq. ft.
Superheater heating surface	1,262 sq. ft.
Equivalent heating surface*	7,045 sq. ft.
Grate area	84 sq. ft.

Tender

Tank	Cylindrical
Frame	Cast steel
Weight	194,600
Wheels, diameter	33 in.
Journals, diameter and length	6 in. by 11 in.
Water capacity	10,000 gal.
Coal capacity	17 tons

*Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface.

A SYSTEM OF LABOR COMPENSATION

A Combination of the Taylor, Piecework and Prusso-Hessian Methods Developed in Russian Railway Shop

BY M. K. SMOGORJEVSKY, M. E. *
Formerly Assistant Superintendent, Dvinsk Railway Shops, Russia

THE marked increase in the costs of production in Russia in recent years has been mainly due to the constantly increasing cost of labor. Highly efficient, new, powerful machinery, labor-saving devices and automatic machinery counteract this increase to a certain extent, but cannot be solely relied upon to keep the cost of production down unless combined with the increased efficiency of labor. Modern equipment is very costly and proves to be but an additional burden if not worked to its full capacity. Therefore, in the vital problem common to all modern industries of how to keep the cost of production down, the question of increasing the efficiency of labor is of the greatest importance, and in many instances it is even more important than modernizing and improving the equipment. This is particularly true in regard to railway shops.

Compulsory methods of increasing the efficiency of workmen have been discarded, as they do not produce results. The prospect of material benefits, otherwise better earnings, is the only motive power that will make an average man work with more zeal. With this end in view, namely, to give the workman an incentive to increase his efficiency, several systems of wage payments have been devised and tried out, but none of them could be considered perfect so far, as none of them equally well satisfies employer and the employee. Before submitting the following plan proposed by the author, a brief, critical review will be made of the most typical systems of wage payments, so as to bring out more clearly the necessary requirements of a perfect system.

STRAIGHT PIECEWORK SYSTEM

A straight piecework system is the oldest and most extensively used up to the present time, and is in operation in Russian railway shops. According to this system, the actual earnings of the men are determined by the piece price and the output, but there are no rules or regulations provided for guidance in determining the piece prices. This matter is left entirely to the judgment of the head of the department, and very often no particular investigation is made of the actual time required for the performance of the work. Independent of the actual earnings, there is a day wage set for each and every man, which is a guarantee of the minimum earnings. This day wage is usually much lower than the actual earnings, and is increased from time to time. The amount of the increase and the period of time after which a man is entitled to such increase is also left to the judgment of the man in charge. Then periodically the actual earnings are summed up for the period of time and the ratio of this total to the sum of the daily wages for the same period serves as a kind of criterion to verify the piece prices.

The weak point of this system is the absence of rules for a determination of the piece prices. Left entirely to the discretion of the man in charge, piece prices bear a highly individual character. Some work happens to be undervalued, so as to leave a very low margin of possible surplus earnings, and some is overvalued. The result is that in the case of undervaluation there is always dissatisfaction on the part of the employees, and in the case of overvaluation, the workmen usually reduce the output purposely, so as not to give any reasons for a readjustment of the piece prices. Each attempt to readjust the prices is met with objections. Consequently this system, while it increases the efficiency in many cases, could not ultimately guarantee the reduction of the cost of production, and, furthermore, it does not guarantee a just compensation to the workmen. Very often a mechanic of rather limited ability makes big pay simply because he was lucky enough to get an overvalued piece of work, while a good man may happen to make just the minimum wage because the job he is working on has been undervalued.

PRUSSO-HESSIAN SYSTEM

This system introduces a new element into consideration, which is the piece time, or the time taken to perform the task

*Mr. Smogorjevsky has traveled abroad investigating the actual results of application of various wage payment systems wherever possible. He invented an instrument for drawing the Pasqual Curve, thus giving the practical application to a solution of three-section of acute angles graphically. Since his connection with the railroad shop at Dvinsk he has studied the systems of wage payments, their application and results, attitude of workmen to these different systems, their psychology and desires. Early in 1913 he began the investigations for the purposes of determining the periods of time consumed per operations and gradually readjusted piece prices and wage rates. At first the attempt to investigate and record results and readjust the piece prices was met with objections, workmen naturally supposing that it is no more than a usual attempt to reduce their earnings. To offset this he resorted to a diplomatic course, placing posters explaining briefly the system and its workings, and held several meetings for the purposes. The result was more than had been expected, the workmen became rather enthusiastic and afterwards co-operated in all possible ways. He began the application of a system in August, 1914, and a year later Dvinsk was evacuated. Of course, in such a short time it is hard to expect to have definite data so as to finally approve or disapprove the system, yet as far as could be judged the results were excellent. In changing to this new system one of the most difficult points was to determine the rates for those that had been working in a place already for a considerable time, it had to be done considering their last earnings, their abilities and age. This article was translated by James Gray, formerly of the Russian Mission of Ways and Communications in America, from an address by Mr. Smogorjevsky in 1914 at the convention of railroad engineers and cost accountants. The address of Mr. Smogorjevsky was approved, and he was authorized to try out the system unofficially. The war and the evacuation of the Dvinsk shops stopped the further experimenting for the time being.

by an average mechanic. The day wage is increased periodically and systematically, according to the length of service and the piece price is determined by the day wage and the piece time. This system gives a more stable basis for determining piece prices, but they are standardized, which from a technical point of view is not advisable because the methods of production change constantly and therefore the piece time of today may be obsolete tomorrow. The method of determining the piece time, although a great improvement as compared with that used in the straight piece work system, can not be considered perfect, as it depends greatly on circumstances. Usually, when given a new piece of work, the mechanic understands that the time required to do it will be considered when determining the piece time and he will purposely slow down so as to get a good price.

The increase of wages periodically and systematically is a good point as it tends to keep the man in one place, but as it is done considering simply the length of service, and no other individual qualities, it fails. The increases do not depend on a man's ability or his zeal, and it doesn't take a good mechanic long to find out that no matter how hard he may try under this system he will never receive very much more than his neighbor of limited abilities. Consequently, he either looks for a better chance in some other place, where he can get a fairer compensation for his skill and extra efforts, or he becomes indifferent to his work.

THE DIFFERENTIAL TAYLOR SYSTEM

This system determines the piece time by an investigation of the periods of time necessary for the performance of each operation. It sets a high standard for the day's work; it pays a high premium for those who are able to live up to that standard and considerably reduces the pay of those who fail, and after repeated failures, these men are usually discharged. The piece time is made up of elementary or unit times necessary for each and every operation, and necessarily it is more correct than when determined in any other way.

The Taylor system artificially sorts out first-class mechanics from the rest who are simply thrown out. The effect on the industry is most beneficial and from the employer's point of view possibly this system is the best, but naturally, it is greatly opposed by employees, and, being thoroughly acquainted with the psychology of the Russian workman, I would say that it could not be applied to a very great extent in Russia. The labor trouble caused by the adoption of this system will more than offset its benefits, and from a human point of view it cannot be recommended. Besides these three systems there are many others, but in most cases they are variations of those just described. Among them is the gang system, where the work is distributed among different gangs and the total gang earnings are divided among its members in proportion to their wage rates. The bonus system also may be mentioned.

In view of the above mentioned limitations it will be evident that the theoretically perfect wage system on the one hand must positively guarantee to the employer the increased efficiency of labor and consequent reduction of costs, and on the other hand, it must guarantee a rational and just compensation to the workmen according to their ability and efforts. It must provide also for the increase of wages with years of service. This will prevent the constant turnover of labor, which is one of the greatest evils of the present-day labor conditions.

The system of wage payment about to be described does not pretend to be an original one but essentially it includes all the good points of the Taylor and the Prusso-Hessian systems with slight variations. Moreover it is a great improvement over those systems and overcomes most of the difficulties which are the natural results of their application.

The Taylor method of determining the piece time as made up of periods of time consumed per operation, is the best. Some of these periods or unit times, as for instance the time necessary to take a cut, depend exclusively on the properties of the machinery, materials used for manufacturing purposes, grades of tool steel, etc. Some of them, like the time consumed in setting up work, regrinding the cutter, will depend on the skill and experience of the workman, and some will depend on supplementary equipment of the shop, such as transportation facilities, lifting facilities, etc. Consequently, the periods of time per operation referred to can be determined by a forestudy and observation of the properties of the machinery and materials. To determine the periods of time per operation is the preliminary and most important part of the work, and if applied in Russian railway shops, where it has never been tried up to the present, it will take probably about two or three years, but when records are completed the matter of determining the piece time, otherwise, summing up the differential times, will be an easy task. Besides this, when any improvement in equipment is made, which will necessitate the readjustment of the piece time, this can be done very easily by determining the period of time per operation on a new machine and substituting it instead of the period of time taken on the old machine.

Very often the same piece of work can be done on various machines and on account of the difference in these machines the piece time will change and therefore the piece time should be determined not only for each and every piece of work, but for each and every machine. This will give valuable information or data to the manufacturer as he will be able to see from these figures the relative advantages of different machines for a particular job. It will also train the workman to understand that the piece time is not something abstract and standard, but is closely related to the properties of the machinery and tools used for the work, and then if any adjustment of piece time becomes necessary on account of improvement of the equipment this will seem but natural and will cause no objections.

The piece time determined by the above investigation is the minimum time, in which it is possible to turn out the work. Its attainment is possible only under ideal conditions and under normal conditions the same piece of work will take a little more time. This increase in time will have to be determined for each shop separately by recording the time consumed per operation by some of the workmen and finding an average. This should be compared with the minimum time, bearing in mind that a margin must be left for an average workman to earn at least a small surplus above the wage rates so as to coax him to intensify his efforts. Considering this increase in piece time as normal, we come to a normal piece time which is the basis of the proposed system.

THE SMOGORJEVSKY SYSTEM

The most convenient wage rate as applied to this system will be the rate per hour. The rate per hour multiplied by the normal piece time will determine the cost per piece. The piece time multiplied by the number of pieces of work turned out will determine the earned hours, so to speak, and the rate per hour multiplied by this number will give the actual earnings in dollars and cents.

The rates per hour, of course, will be greatly influenced by the perpetual law of supply and demand, and must be set so as to allow an average workman to earn a standard wage, when working the regular number of hours per day. In regard to Russian railway shops the rates will have to be increased as at present they are unreasonably low.

As each workman, according to his individual qualities, can perform the work in more or less than normal time, his daily earnings will change accordingly and the ratio of his earnings for any period of time to the total of his wages for the same period of time will determine his efficiency. With the increased efficiency of labor, the cost of production will go down. The efficient mechanic will be more useful

to the industry and therefore he will expect and ought to get more than his neighbor of more limited ability. Under this system of wage rates he will be able to go as high as his skill and ambition will permit.

But a man's wage rate should depend also on his length of service because with years he gets more experience and more knowledge of his line of trade. In short, he is more valuable than a new man who just starts in. The man who has been in the shop for several years knows all the ins and outs, and there is no time lost in breaking him in, so the raise in wages with years is no more than just. The Prusso-Hessian system took into consideration the length of service but failed because other qualities were neglected. Men differ greatly in their personal characteristics and abilities and those that are more skilled, more experienced and more attentive to their work must be distinguished.

In giving raises then, it is necessary to take into consideration three co-efficients. First, *the co-efficient of efficiency,* which is the ratio of the total earnings for any period of time to the total wages for the same period. Second, *the co-efficient of quality,* which is the ratio of the difference of the earnings and costs of the rejected work to the total earnings. For instance, if the yearly earnings of a mechanic are \$1,000 and the cost of rejected work is \$30, then the co-efficient of quality will be: (\$1,000 — \$30) : \$1,000 = \$970: \$1,000 = .97. Third, *the co-efficient of attendance,* which is the ratio of the number of days the workman has been in the shop to the total of working days for the same period. The amount of raise should be standardized, but the periods of time, after which a man is entitled to a raise will differ according to the product of his co-efficients, and strictly in accordance with a wage scale, which will look something like the following:

	Co-efficients				
Classes	Efficiency α	Quality β	Attendance μ	$\alpha\beta\mu$	Periods of time after which the workmen are entitled to a raise
I	1.3-1.4	.99	.98	1.3	1.4 years
II	1.2-1.299	.98	.96	1.16	1.6 years
III	1.1-1.199	.97	.94	1.03	1.8 years
IV	1.0-1.099	.96	.91	.91	2.0 years
V	Less than 1	...	...	Less than .91	Wage is not increased.

As seen from the above table, all employees are grouped in five classes, according to their individual qualities. A man of each group will get an increase after a certain period of time as indicated. The men that will come into the fifth group, whose product of co-efficients is below one do not get the increase, of course, and eventually are discharged if after a fair trial on some other work they fail to make a better showing. It may be stated that the above table is given simply for the purpose of illustrating the system, and does not represent actual figures taken in practice. In reality, according to circumstances the number of classes could be increased or decreased, and also the periods of time, after which a man is entitled to a higher wage, may be determined by the actual figures for the three co-efficients.

Periodical and systematic increases in wages depending on these three co-efficients is the basic principle of the system which for the sake of clearness may be summed up as follows:

First.—By investigation, observation and a thorough study the periods of time necessary for the performance of each and every operation for each and every machine are determined. These elementary times are summed up, thus determining the minimum piece time or *base time.*

Second.—The minimum piece time is increased according to experimental data, thus determining the *normal piece time.*

Third.—A rate per hour is set for every class of mechanic, and this rate is increased systematically according to scale in reverse proportion to the product of their co-efficients of efficiency, quality and attendance, the co-efficients being the abstract expression of individual qualities.

Fourth.—Output and normal piece time determine the number of hours the workman gets paid for; the rate per hour and this number of hours determine the actual earnings, and the rate multiplied by the normal piece time will give the cost per piece.

The system of wage payments being outlined, it remains to prove that it will come up to the requirements of a better system; i. e., to prove whether it guarantees the employer the increased efficiency of labor and reduction of costs, and to the workmen a just compensation according to their skill, experience, extra efforts, and length of service. The answers to these questions are practically self-evident, but the following discussion will perhaps convince those who are skeptical.

The workman increases his efficiency when he has a reasonable outside impulse to do so. This impulse, as mentioned before, could be nothing else but the prospect of better earnings. As explained, this system gives every man a chance to perform his work in a shorter time and thus increase his earnings. On the other hand, the piece price is determined by the rate per hour and piece time. If a man gets more per hour he gets a better piece price. Everyone has an equal chance to increase his rate per hour by increasing his co-efficients of efficiency, quality and attendance. The higher these co-efficients are, the sooner he will get the increase. These two reasons prompt the men to intensify their efforts to turn out more and better work, and the effects on the industry will no doubt be the increased efficiency of labor and reduction of costs. The actual earnings of the workmen as affected by these two factors, i. e., increase of efficiency and periodical increase of wage rates, are illustrated graphically in Fig. 1. The scientific method of determining the piece times also will do much for the reduction of costs, at least in those industries where it has not been applied up to the present, and where many operations just now happen to be considerably overvalued.

In regard to the second requirement of the system, that a just compensation be guaranteed for everyone, there are four factors to consider; output, length of service, or age of workmen, and skill or experience. Therefore, the system proposed is believed to be more just than any other, as it takes them all into consideration. Furthermore, the individual qualities are valued objectively, referring to actual records of performance, and all the increases in wages or adjustments of piece time are done systematically according to wage payment scales. The men are given a fair and equal chance to increase their earnings. This system also eliminates all petty squabbles among the men themselves, and between the men and the administration.

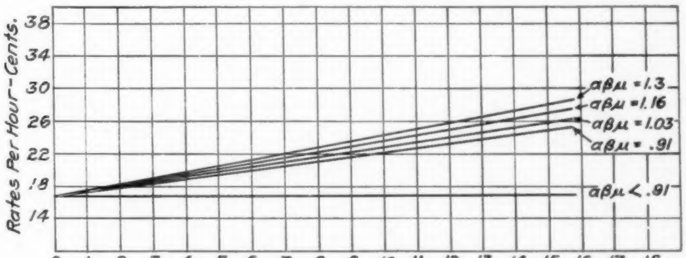


Fig. 1—Graphical Representation of Wage Rate Increases

The increase of wages of the workman with the length of time of his being in employ is one of the provisions of the system, so it satisfies the employee in this respect, and on the other hand it prevents labor turnover and saves the employer the losses resulting from the constant exchange of men, such as time lost in breaking in a new man, extra office expense, advertisements, etc., consequently also contributing to the lowering of the costs of production. In short, the workmen will be satisfied, the increase of the efficiency of labor will

be assured and the result will be a reduction in the cost of production provided the periodical increase in wages does not offset the benefits of other factors that make up the system.

REDUCTION IN COST OF PRODUCTION

This is a point concerning which questions may be raised and the following will prove that it will not happen.

Suppose that the total output of a certain shop and the total number of men employed remain constant. Under such circumstances any fluctuation of average wage rates will cause a change in costs per piece. An increase of wage rates will cause an increase of costs per piece and vice versa. As the wage rates are raised from time to time and the costs per piece are determined by the rate per hour and time consumed per piece, it is obvious that the cost of production of the same piece of work will vary depending on the rate per hour of the man who is working on it, yet the total costs can be maintained on the same level or lowered if it is possible to keep the average rate constant or lower it.

To prove that under this system the increase of wage rates of some of the men will not increase the average rate, the relation between the factors that influence this average rate will have to be expressed in algebraic formulae.

Let:

p_0 = Average rate per hour of a workman for all the time of his being employed.
p = Average rate per hour of all the men in the shop at any time.
T = Average length of employment of a workman.
t = Average interval between two consecutive raises in wages.
$n = \frac{T-t}{t}$ = Average number of raises in wages a workman gets during all the time of his being in employ.
m = Amount of raise in cents.
α = Co-efficient, which is ratio of the starting wage to an average wage.
$p_1 = \alpha p_0$ = Starting rate per hour.
β = Co-efficient, which is the ratio of maximum wage to average wage.
$p_2 = \beta p_0 = \alpha p_0 + mn$ = Maximum rate per hour.
y = Number of men changed during one year, per 100 men.
$x = yt$ = Number of men changed between two consecutive raises, per 100 men.

The average wage could be determined by adding the minimum and maximum wages and dividing by two which gives the following equation:

$$p_0 = \frac{p_1 + p_2}{2} = \frac{\alpha p_0 + \beta p_0}{2} = \frac{2\alpha p_0 + mn}{2};$$

or substituting $\frac{T-t}{t}$ instead of n:

$$p_0 = \frac{m(T-t)}{2t(1-\alpha)} \qquad (1)$$

Next, to express in a formula the relation between p and y supposing that the turnover of labor is due solely to natural causes, such as death, loss of ability, etc., and that the average rate should remain constant. Under this supposition we may say that most of the men falling out will be the ones that get the highest rate, $p_2 = \beta p_0$ and all that start are getting $p_1 = \alpha\, p_0$.

Total of hour rates per 100 men at the average rate = p_0 will be

$$100p \qquad (a)$$

After a completion of an exchange of x workmen between two consecutive raises, the same total of rates per 100 men can be expressed thus:

$$(100 - x)\,(p^1 + m) + \alpha p x \qquad (b)$$

where

$$p^1 = \frac{100p - \beta p x}{100 - x} = \frac{(100 - \beta x)p}{100 - x} \qquad (c)$$

As the total of rates per hour per any number of men ought to be equal at any time

$$100p = (100 - x)\,(p^1 + m) + \alpha p x$$

or substituting instead of p^1 its meaning from (c) and solving the equation considering the p to be unknown, the equation becomes:

$$p = \frac{(100 - x)m}{2x(1 - \alpha)} \qquad (d)$$

or substituting yt instead of x:

$$p = \frac{(100 - yt)m}{2yt(1 - \alpha)} \qquad (2)$$

As the average rate of any workman for all the time of his being in employ should not differ materially from an average rate per hour of all the workmen at any time, equations (1) and (2) give a new equation:

$$\frac{m(T-t)}{2t(1 - \alpha)} = \frac{m(100 - yt)}{2yt(1 - \alpha)} \qquad (3)$$

Reducing this equation to its simplest form and solving it considering the y to be unknown:

$$y = \frac{100}{T} \qquad (4)$$

If $T = 40$ years, then $y = 2.5$ men per 100 men or 2.5 per cent.

Equation (4), which is the result of the reduction of equation (3) to its simplest form, shows that the constancy of average rate per hour depends exclusively on the average of how long the workman remains in employ. This equation is a mathematical expression of a common politico-economical law determining the average per cent of labor turnover due to natural causes. The very same result can be obtained also in another way, as follows:

If the average length of time of being in employ = T years, then in 100 years the staff of employees will exchange completely $\frac{100}{T}$ times, in one year $\frac{1}{T}$ times and the exchange per 100 men will be $\frac{100}{T} = y$.

Substituting this meaning for y and reducing to its simplest form, equation (2) becomes

$$p = \frac{m(T - t)}{2t(1 - \alpha)},$$

or in other words the same expression as that for p_0 in equation (1). This proves that the equality of average rate per hour of all the men at any time and average rate per hour of any workman for all the time of his being in employ are possible

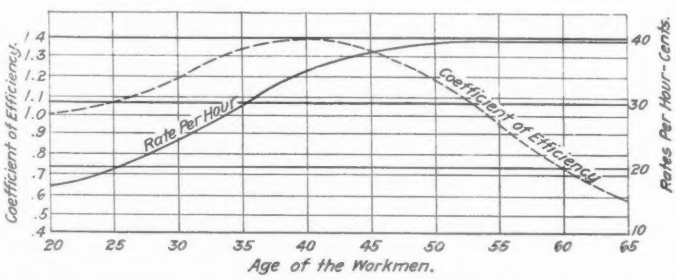


Fig. 2—A Comparison of Wages and Efficiency with Increasing Years

only on condition that the turnover of labor will be due but to natural causes. In reality the men leave the employ also for many other reasons besides the natural causes, and consequently the concrete meaning for T decreases, thus lowering the average rate per hour if m, t and α remain constant. This can be readily seen from equation (1) where T is one of the factors in the numerator of a fraction.

For the sake of precaution all the above calculations were made on supposition that the concrete meaning of T is determined by the natural causes. In reality the meaning of T as determined by statistical data will be considerably higher

and therefore all the above is an ample proof that periodical increases of wages will not cause an increase of the total costs of production.

Equations (1) and (2) express the mathematical relation between all the factors that influence the average rate, and enable us to find suitable meanings for some of them if the rest are known.

The meaning for T cannot be chosen, but is determined by the statistical data, then y is found from the equation $y = \frac{100}{T}$. p, m and a are determined by existing standards of wages. For instance, in case the lathe department of Dvinsk Railroad shops, where the average age of the workmen is 35 years, the starting age is 20, and the average rate is 28 cents per hour, we will have

$$\frac{20 + (20 + T)}{2} = 35;\ 40 + T = 70;\ T = 30 \text{ years.}$$

consequently

$$y = \frac{100}{T} = \frac{100}{30} = 3\tfrac{1}{3}, \text{ or } 3.3\% \text{ approximately.}$$

If $p = 28$ cents, then, considering the standards of wages at the present time in Dvinsk shops, $m = 1$ and $a = .6$ would be most suitable.

Considering that the exchange of workmen is due but to natural causes, and that under these circumstances $T = 40$, we can, from equation (1), determine the meaning for t

$$t = \frac{mT}{2p(1 - a) + m} = \frac{40}{56(1 - .6) + 1} = \frac{40}{23.4} = 1.7 \text{ approximately.}$$

If $t = 1.7$, then $n = \frac{T - t}{t} = \frac{40 - 1.7}{1.7} = \frac{38.3}{1.7} = 23$ approximately. 1.7 of a year being the average period of time between two consecutive increases in wages should be taken as a basis for constructing the scale of wages.

If $p = 28$, $m = 1$, $a = .6$, $t = 1.7$, and $n = 23$, then:
starting wage rate $p_1 = ap = .6 \times 28 = 17$ cents per hour (approx.)
highest wage rate $p_2 = \beta p = ap + mn = 17 + 23 = 40$ cents per hour (approx.)

or the starting wage rate will be 40 per cent below the average and the highest wage will be 43 per cent above the average and about two and a half times the starting wage rate. This difference between the starting wage and the highest wage gives ample impulse to the workingman to increase his efficiency so as to earn more, and at the same time will keep him in the same shop, probably in a new shop he will have to start again from the bottom.

In conclusion the method of distribution of surplus earnings is important. Various systems take care of these surplus earnings in different ways. The Taylor and Prusso-Hessian systems pay it all to the workmen, and bonus systems (such as Rowan's, Helsey's, or Siebenfreud's) pay to the workmen but a part, retaining the rest. Either of these methods is equally applicable to the new system, but it would seem that the retaining of any portion of the surplus earnings by the employer is unjust, because he gets his share from the increased output per same running expenses. Of course, it may be claimed that in many instances the employer keeps some men in the shop simply out of sympathy, although their efficiency is much lower on account of old age, and therefore the retained surplus earnings go to cover the deficiency of such men.

The wages and efficiency of an average workman are presented graphically in Fig. 2.

The efficiency of a man at about 20 is practically normal; later on, with years, he acquires skill and experience, his efficiency increases, and at about 40 it reaches its highest point. Then it begins to decline, slowly at start, and more rapidly later on, and at about 55 it falls below the normal. At the same time the wages at the start will be much lower than the average, and even at the time of his highest efficiency he will get a rate below the highest. Later on, however, although his efficiency has decreased, yet until the product of his co-efficients of efficiency, quality and attendance will be still above 1 he will continue to receive increases for his work. Only at about 45 will he receive the rate corresponding to his efficiency at that time. Therefore, the increases of earnings which he will get after 45 will compensate him for the inadequate earnings during the previous years. At 55 years of age efficiency will come down to normal, the increases are stopped, and he gets the last highest wage for the rest of the time. The wage scale being constructed on assumption that $T = 40$, therefore if a man will work even up to 60 years of age, the employer will suffer no losses.

The systems that give all the surplus to the employee usually do not care what becomes of the man when he reaches the point where his efficiency falls below the normal, simply throwing him out, and the systems that retain some portion of the surplus and keep some men in the shop out of sympathy have to bear the burden, and in case there is too much sympathy it may happen that the retained surplus will not be enough to cover the extra expenses.

As I mentioned before, either of the methods is applicable to the proposed system, but it would probably be more rational to retain a portion and apply it to the formation of a pension fund.

At present in most cases the workingman living from hand to mouth is left entirely unprovided for when old age comes, and this compels him to stay in the shop until his last strength gives out. But if there will be some pension provided, which as suggested could be formed out of the retained portion of surplus earnings, it would, on the one hand, assure this old workman a small income, and on the other, relieve the employer from the extra expense incurred by keeping the old man in employ out of sympathy. This would release his place for a more efficient hand.

The organization of shops is one of the most important factors of progress in industries, and the system of wage payments is one of its vital elements. Therefore, the question of deciding upon the right system to be adopted in a modern industrial organization should be considered very seriously.

LIMITATIONS TO THE CAPACITY OF COAL CARS

About twenty years ago the introduction of the steel coal car of 50 tons capacity was a distinct advance in increasing the size of coal carrying units and effected considerable improvement in the ratio of paying load to the gross load of the car. During the past few years there has been a progressive tendency toward a still further increase in the capacity of coal cars, marked first by the development of the 57½ ton car and passing through successive steps of 70, 75 and 100 tons capacity to the present maximum of 120 tons capacity, several of which are now in service. It is evident that there must be a limit to the extension of this development, determined by the strength of track and bridge structures and clearance limitations.

A study has been made by the Pennsylvania Railroad to determine this limit, from which it is concluded that the maximum has already been reached and that permissible axle loads offer no opportunity for its extension. This investigation took into consideration bridge loading, practical limitation of wheel loads, and the location of center of gravity of the loaded car. The bridge limitations were assumed to be Cooper's E-60 bridge loading, which places a limit on the weight of the car of 6,000 lb. per linear foot

of coupled length. The maximum wheel loading which the rails are capable of supporting without undue deformation was assumed to be 52,500 lb. per axle, the maximum for a 6-in. by 11-in. M. C. B. axle. This is a larger size axle than is now in common use, although the Pennsylvania Railroad now has something over 30,000 cars of 70 tons capacity under which four-wheel trucks with axles of this size are in use.

The maximum axle loading was determined on the basis of the results obtained by the sub-committee of the American Railway Engineering Association on Rational Relations Between Intensity of Pressure Due to Wheel Loads and Resistance of Rail Steel to Crushing and Deformation, in a series of tests conducted on the rolling test machine at the Sparrows Point plant of the Bethlehem Steel Company. On this machine a five-foot section of rail was caused to travel a distance of four feet back and forth under a chilled cast iron car wheel revolving on roller bearings, through which the load was applied. The test specimens were taken from a new Pennsylvania standard section 100-lb. rail. The effect of the load on the metal at the head of the rail was determined by observing the closure of a series of 3/32-in. standard taper holes placed horizontally below the surface of the tread, approximately ⅛ in., 3/16 in., ¼ in., 5/16 in., and ⅜ in. The closure of the holes was observed by the use of taper plugs with markings approximately ⅛ in. apart along the taper, so that the difference in diameter between any two consecutive marks was as near as could be measured .001 in.

In the first test, beginning with a load of 30,000 lb., 110,000 passes of the rail were made under the wheel. The load was then increased to 35,000 lb. and 120,000 additional passes were run. The first 50 passes of the wheel indicated that all of the horizontal holes were closing. After 500 passes all of the horizontal holes had closed by amounts varying from .001 to .003 in. in diameter. From this point closure of the deeper holes became very slow. The average width of the contact of the wheel on the rail increased slightly at an approximately uniform rate throughout the test and the contact area gradually moved toward the gage side of the rail. The average area of contact increased from .3 sq. in. after 10,000 passes to approximately .475 sq. in. at the end of the test, but the change proceeded in an erratic manner.

The initial passes of the wheel over the first rail specimen indicated an immediate closure of the holes, extending even to the deepest holes, ⅜ in. below the surface of the tread. The test of the second specimen was started with a light load of 15,000 lb., increasing successively to 20,000 lb., 25,000 lb. and 30,000 lb. With a load of 15,000 lb., 25,000 passes were run and no closure whatever was observed. After 26,000 passes had been run with a load of 20,000 lb., no closure was observed. Throughout these two periods of the test, however, the width of contact constantly increased and the path of the contact gradually moved toward the gage side of the head. A very slow closure of from .0005 in. to .0015 in. was noted in the holes nearest the tread after 110,000 passes had been run with a load of 25,000 lb. The lead was finally increased to 30,000 lb. and 105,000 passes run, with the result that an additional closure of from .005 to .0012 in. was noticed in the holes nearest the top of the rail.

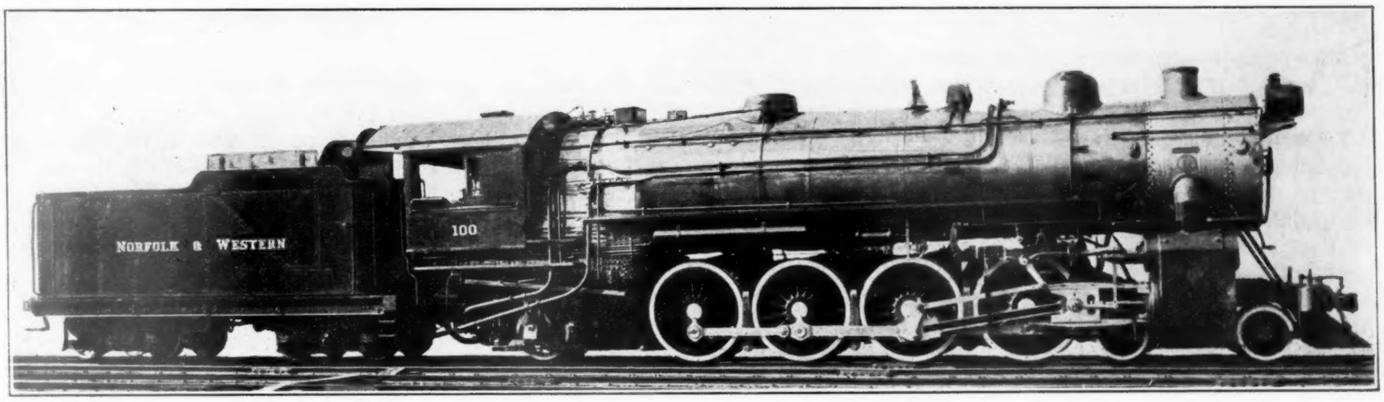
During the entire test no closure was observed in the holes 5/16 in. and 3/8 in. below the surface of the tread. Comparing the first with the second test, it should be noted that with an initial load of 30,000 lb. all the holes had closed by amounts varying from .0035 in. in the deeper holes to .0085 in. in the holes nearer the surface, at the end of 110,000 passes. Scleroscope readings clearly indicated an immediate hardening of the surface under the wheel which gradually increased during each test. There is no proof that the maximum hardness through the cold rolling had been reached at the termination of either test.

With a maximum of 52,500 lb. load per axle the maximum permissible total weight of car and lading is established at 315,000 lb., using six-wheel trucks. To meet the requirements of Cooper's E-60 bridge loading, the coupled length of such a car must not be less than 52 ft. 6 in. On the basis of this length the height from the rail to the center of gravity of the car was determined to be 6 ft. 6 in., which is the upper limit of safety. To reduce this height the length of the car must be increased.

The net weight of coal in the load of such a car obviously depends upon the light weight of the car. In the study made by the Pennsylvania Railroad this is estimated to be between 75,000 lb. and 80,000 lb., which gives a ratio of paying load to gross load of, respectively, 76.2 per cent and 74.6 per cent. Assuming that the lower limit of light weight be attained, the total weight of the load in the car will be 240,000 lb. or 120 tons.

As far as conclusions may be drawn from these tests, it appears that a load equivalent to a 60,000-lb. axle load effects a working of the metal in the head of the rail for a considerable depth. Such a load is probably too high to be imposed on the rail through a small diameter wheel. When previously subjected to the rolling action of a much lighter load, the depth to which the metal of the rail is worked by the high load is materially reduced.

What Happens to Railway Cars on the British Front



DRAFTING MODERN LOCOMOTIVES

Improvements Effected by a Study of Draft Conditions on Norfolk & Western 4-8-2 Type Engines

BY H. W. CODDINGTON
Engineer of Tests, Norfolk & Western, Roanoke, Va.

I

THE lines of the Norfolk & Western, as they pass through and over the Blue Ridge and Allegheny mountains in their course from the Atlantic coast to the Ohio plains, have encountered many natural obstacles, among which heavy mountain grades have been the most difficult to avoid. These heavy ruling grades in the mountainous regions have encouraged the continued development of larger and more powerful power units, of which the Mallet type locomotive is an expression for freight service, while the mountain type locomotive is the result of the effort to meet the demands of heavy passenger service through the same districts.

In the summer of 1916, the Norfolk and Western designed and built in its shops at Roanoke, Virginia, six mountain type locomotives. These locomotives are stoker-fired and are identified by the road as class K1. The general dimensions are as follows:

Type	4-8-2
Service	passenger
Total weight	347,000 lb.
Weight on drivers	236,000 lb.
Cylinders	29 in. by 28 in.
Steam pressure	200 lb.
Diameter of drivers	70 in.
Total heating surface, including superheater (36 elements)	4,863 sq. ft.
Grate area	80.3 sq. ft.
Tractive effort	57,200 lb.

When the first group of class K1 locomotives was placed in service, some trouble was experienced in maintaining a satisfactory steam pressure, and while it is true that the engines rarely completely failed for steam, it is equally true that some of them operated on a very narrow margin, barely making the schedule under the most favorable conditions. These engines are provided with boilers of liberal dimensions and confidence was expressed that the trouble was not due to an insufficient boiler capacity, but probably centered about some question of combustion. In view of this, it was decided to make observations and later conduct some experiments after making certain proposed changes in the locomotive front end. The changes anticipated were along the line of a larger exhaust stand, a larger nozzle and a larger stack.

Engine No. 100, which was regularly assigned to through passenger service, was selected for these observations. This locomotive was considered to be perhaps the poorest steaming locomotive of the group. The locomotive was shopped for the application of the necessary test equipment, consisting of draft gages, steam indicator, speed recorder, signal systems and pressure gages. Pitot tubes were provided along the length of the stack for determining the position of the exhaust column. Provision was also made for obtaining samples of combustion gases. The first preliminary observations were made on January 3, 1917, on train No. 25, between Roanoke and Christiansburg, Virginia. This type of locomotive should carry, normally, 200 lb. steam pressure, but on this run it was observed that the steam pressure ranged from 157 lb. to 192 lb. It was also observed that the draft was unusually low, indicating the necessity for improvement in this respect.

The test runs were all made in the district referred to in the preceeding paragraph. A train of empty passenger equipment cars was provided and the train was operated out of Roanoke as a second section of some passenger train. This district presents an opportunity for observation both under high speed and heavy grade operating conditions. From Roanoke to Elliston, Virginia, a comparatively level or undulating grade is traversed for about 20 miles, while from Elliston to Christiansburg a heavy mountain grade of 1.32 per cent is encountered for a distance of 13 miles. While observations were made under conditions of high speed from Roanoke to Elliston, it was observed that the operating conditions on the mountain grade were more uniform and presented a better opportunity for obtaining consistent data than in the high speed district. It was also possible to make several trips on the heavy grade between Elliston and Christiansburg each day, which would not have been possible had an attempt been made to cover the complete district from Roanoke to Christiansburg. Therefore, only the data compiled from the observations made while operating on the heavy grade will be presented. During these runs an effort was made to maintain an average speed of 32 miles an hour.

The first test run was made March 9, 1917. In this test an opportunity was afforded for establishing the proper location for operating the reverse bar and throttle, as well as the train tonnage. The position established for the reverse bar was the eighth notch from the center, which gave approximately 57 per cent cut-off, while a full throttle was maintained at all times. The weight of the train ranged from

600 tons to 640 tons, the tonnage being varied as suggested by changes in the locomotive. For instance, when the engine was provided with a larger nozzle, which resulted in reduced exhaust pressure, it was found that an increase in tonnage was required in order not to exceed the desired speed. Before any alterations were made in the front end a complete test was made of the locomotive in its original condition to obtain data for use as a basis for comparison.

In considering the possibility of improving the draft conditions upon this type of locomotive, the results of draft tests conducted by Dr. W. F. M. Goss, as reported in his book entitled "Locomotive Performance," were carefully studied. It was found, however, that the formulae established by Dr. Goss in his study of front ends conducted upon small locomotives did not apply readily to the larger types of locomotives, of which the Norfolk & Western class K1 is an example. Hence the study of this problem was in a measure elementary; the developments were the result of the study of the data obtained from each individual day's run and not the result of following a preconceived program. The results from every test conducted have not been presented, as there were some for which the data were not of an enlightening character, and these have necessarily been eliminated in the final compilation.

In the preparation for the test, the engine was equipped on one side with a Crosby steam engine indicator and a steam gage connection to the exhaust passage in the cylinder.

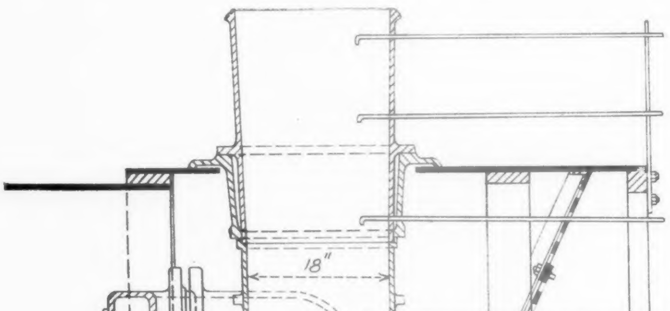


Fig. 1—The Original Front End Arrangement of the N. & W. Mountain Type Locomotives

Along the length of the stack, at intervals of approximately 10 in., were five Pitot tubes extending through the stack and front end space to the front of the locomotive. The outside terminal of each of these tubes was attached to an open mercury manometer tube for establishing the position of the exhaust jet with reference to the inside surface of the stack. The position of the Pitot tubes when a zero reading on the manometer was registered indicated the position of the edge of the exhaust jet. The location of the Pitot tubes is shown in Figs. 1 and 2.

Cab readings were taken of the boiler pressure, draft at three different locations in the boiler, position of reverse bar and throttle, location, time and speed. One of the observers in the locomotive cab operated an electric signal system which announced to the observers on the front end when observations were to be made. An annunciator located in the locomotive cab was employed so that the observers on the

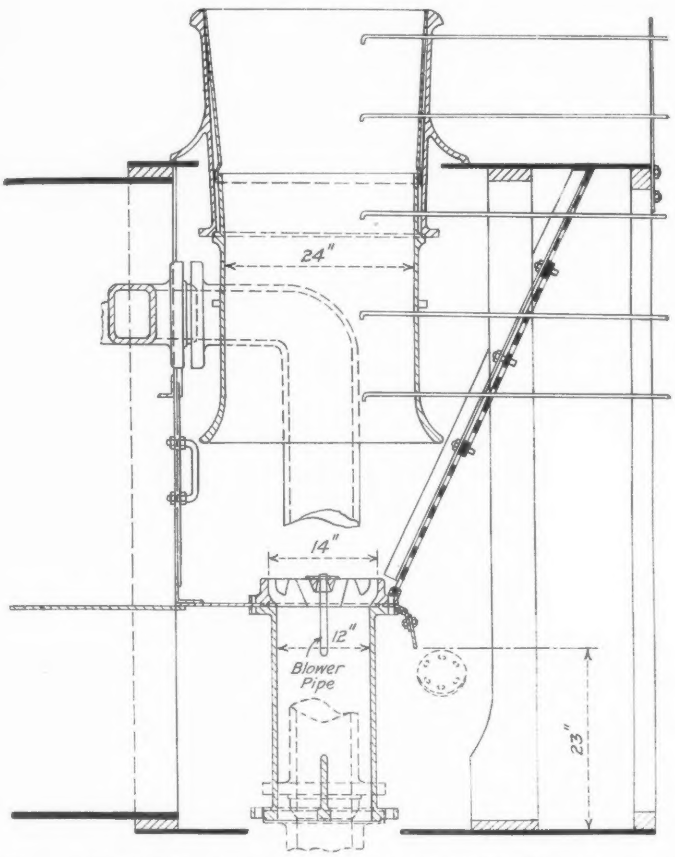


Fig. 2—Front End Arrangement of the N. & W. Mountain Type Locomotives Developed as the Result of the Drafting Tests

locomotive front could signal when their observations were completed. In this manner all of the observations were made at approximately the same time and under the same conditions of performance. Provision was made for obtaining a sample of the combustion gases while the trip was in full progress, a continuous sample being taken for a period of six to eight minutes. Samples of the fuel used were obtained by the cab observers at intervals throughout the test trip and later analyzed.

The tender behind the locomotive was fitted with water gages and the water consumption for each trip was observed. Care was exercised to have the locomotive standing on track of the same gradient with the same amount of water in the boiler at the beginning and end of each trip.

The test runs made were 74 in number and covered a period from March 9, 1917, to July 27, 1917.

Fig. 1 represents the front end arrangement which was standard for the mountain type locomotives at the time the engine was taken out of service. The arrangement consisted of an 18-in. diameter stack with a 26½-in. inside extension and a plain circular 7-in. diameter nozzle with a ⅜-in. bridge, having a free area of 35.86 sq. in. The arrangement adopted as standard as a result of the investigation is shown in Fig. 2. It consists of a 24-in. diameter stack, 26½-in. inside extension and a 14-in. diameter annular waffle iron nozzle having an effective area of 49.35 sq. in. The results

obtained from these two front end arrangements may be contrasted as follows:

Front end arrangement	Original	Modified
Run number	17	74
Type of nozzle	⅜-in. bridge	A-42
Speed, miles per hour	33	29.5
Boiler pressure, lb. per sq. in	192.5	200.2
Front end draft, in. water	8.91	8.63
Exhaust pressure, lb. per sq. in	10.94	4.54
Draft efficiency	.029	.068
Area of nozzle	35.86	49.35

Representative indicator cards selected from runs No. 17 and 70 are presented in Fig. 3.

Draft improvement has been undertaken on the Norfolk

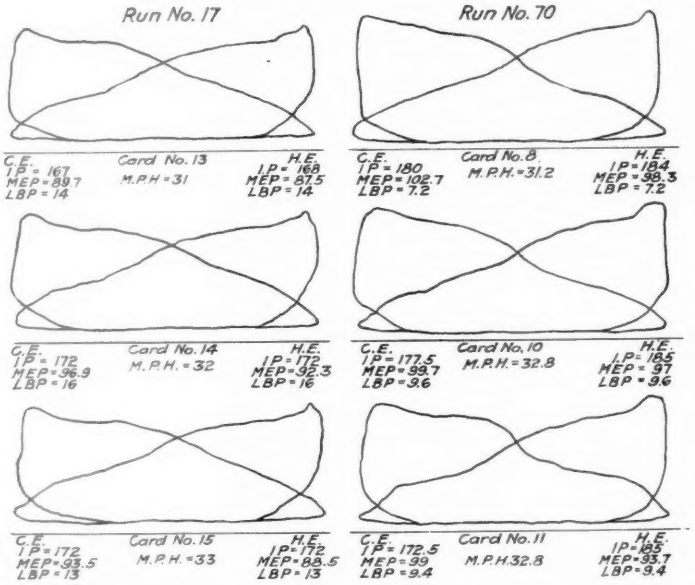


Fig. 3—Representative Indicator Cards Taken with the Original and the Modified Front End Arrangements

& Western's 4-8-0 type freight locomotives, class M-2. The same principles have been applied and good results obtained. The draft has been increased 39 per cent; exhaust pressure reduced 22 per cent; draft efficiency increased 76 per cent. The exhaust nozzle has been increased in size from 5¾ in. to an area equivalent to 6¼ in. in diameter. With still further changes, there is a possibility of improving upon the results already obtained.

The details of the tests and the sequence of the steps which led up to the final development, will be discussed in the succeeding articles.

(*To be continued.*)

COAL PRODUCTION.—Production of bituminous coal for the month of April, 1918, is estimated at 46,478,000 net tons, an increase of 4,400,000 fons, or 10 per cent over April of last year. Production for the four months ended April, 1918, is estimated at 181,992,000 net tons, an increase of over 5,000,000 net tons, or three per cent compared with the same four months of 1917, according to the reports of the Geological Survey. The output of bituminous coal declined slightly during the week ended May 4, the total production being estimated at 11,559,000 net tons. During the week ended May 11 there was a gain in production of 2.2 per cent over the week of May 4, exceeding slightly the record week of April 27, the total output being estimated at 11,806,000 tons. During the week ended May 18 there was a slight decrease, in coal production, the output being estimated at 11,732,000 tons, an average daily production of 1,955,000 tons, compared with a daily average of 1,829,000 tons during the month of May, 1917.

CONSERVE AND RECLAIM MATERIAL

The Railroad Administration has made through its regional directors a strong appeal for conserving material and reclaiming and repairing old material. The following is from a circular letter issued by C. H. Markham, regional director of the southern territory, to all the railroads under his jurisdiction:

In view of the increasing difficulty in obtaining a sufficient amount of iron and steel products, it is more important now than ever that every piece of material that is fit for further use, or that can be repaired and used, should be used in place of new material. Many articles of scrap by reworking may also be used, and the amount of new material required very considerably reduced.

Under no circumstances must any material be scrapped until it is positively known that:

First—It cannot be repaired by some process.

Second—Or that the cost of repairs by suitable means is prohibitive.

Third—Or that by some economical process, it may not be converted into another class of useful material.

Innumerable ways by which material may be reclaimed is already known to those in charge of the handling. From time to time, methods evolved on some particular road will be valuable to others. Articles and methods, with full description when necessary, should be sent to this office from time to time, so that they may be published for the benefit of the other regional roads.

Everybody should bear in mind that, due to the shortage of all supplies, many articles that under normal conditions could not be economically used again, can and must be repaired, if, by so doing, any saving of material, however small, can be effected. There are innumerable ways by which the desired results may be obtained, and in connection with the oxy-acetylene torch, and electric arc welders, material that formerly went into the scrap can be reclaimed and made almost as good as new. Worn parts can be built up in many cases without being removed. Flues and firebox sheets that under old conditions had to be removed, can be repaired and power kept in service that otherwise would be in the shop.

The use of reclaiming rolls for working up iron and steel scrap into rerolled usable sizes is a good proposition.

Any requests for apparatus or devices that will assist in the maximum utilization of material that would otherwise be scrapped, will be given proper consideration.

I would like each railroad to organize a reclamation committee, which will make a thorough study of each department, and keep me in touch with what is being done, making recommendations from time to time of devices or apparatus that will bring about the conservation of all kinds of new material.

Previous to the organization of the reclaiming committee, there should be appointed at once a committee consisting of a competent stenograher, a representative of the mechanical department, maintenance of way department and storekeepers' department, which should immediately start and go to all general storehouses, local stores, motive power shops, maintenance of way bridge and building shops, car inspectors' building, section houses, and maintenance of way material yards, to see that the following instructions are complied with:

1. See that all scrap, wherever found, is noted and arrangements made to ship such as should be handled to the general stores immediately, a record being kept of such material as requires future handling to be done later.
2. Go over store stocks, material yards and arrange for proper distribution or disposal of any surplus material not required in a reasonable time.
3. Go over store stocks and material yards and arrange for the disposal of all obsolete material.
4. See that disposition is made of all articles held for possible future use at motive power shops, bridge and building shops and material yards, whose probable use is so remote as to make it inadvisable to hold.
5. Visit all car inspection points and section houses, and see that arrangements are made for the prompt shipment of all scrap to central

point, all obsolete and surplus material moved to general storehouses, to be later disposed of in the proper manner.

6. In general, see that all articles made in part or wholly of metals or rubber that are stored at any point for possible future use, but which there is no reasonable prospect of using, is immediately given proper disposition.

The following is a partial list of materials to be reclaimed and repaired, and methods to conserve the use of new supplies:

All bar iron stock of bolt sizes to be straightened and cut up for bolts.

All bolts broken or with battered threads, to be cut to smaller lengths and rethreaded.

All brass fittings from parts of air pumps, injectors, lubricators, steam gages, cocks, etc., to be carefully examined and repaired if possible.

In scrapping articles which may be composed of one or more materials, if necessary, break them up and remove all brass.

Brake beams bent with broken or missing parts, straightened and new parts applied.

All forgings, which by straightening and repairing, can be re-used.

Scrap car axles to be drawn down to arch bar and drawbar yoke sizes and used for this purpose, and in any cases where there is a surplus of axles, they may be drawn into turret lathe stock.

All nuts, either loose or on broken bolts, to be retapped and put in stock.

Car journal bearings, where end wear is not excessive, to be relined.

In connection with reclaiming rolls, scrap arch bars, drawbar yokes and other heavy scrap to be rerolled into bolt stock.

Worn coupler knuckles can be built up by oxy-acetylene, and used on work cars, yard engines, etc.

Where a grey iron foundry is operated in connection with the railroad plant, no cast iron should be sold, but all scrap utilized. All castings which are fit for further use or may be repaired, should be given the closest inspection.

All structural steel should be cut apart and shapes thus secured frequently can be utilized in repairs to steel cars, etc.

Old tin car roofing should be burned and the spelter melted and collected.

Coil springs, where not broken, should be heated, reset and retempered. Broken coil springs should be straightened, and bar steel used for manufacturing track tools, pinch bars, cold chisels, etc.

Elliptic springs with broken leaves should have the broken leaves replaced and the springs returned to storeroom.

All waste for journal packing should be carefully reworked. Worn waste from passenger equipment after reworking and if not fit for passenger equipment should be used in freight service.

All dirty wiping waste should be reworked by steam cleansing in a centrifugal washer.

Couplers, knuckles, hydraulic or power jacks, draft gear and parts, chains, pipe fittings, journal boxes and truck frames, where through accident or other causes, are found on line of road, should be promptly sent in to some shop where this second-hand material can be repaired and placed back in service.

There is a very great shortage of crude rubber due to the constantly increasing uses being found for it, and the supply not increasing in the same ratio as the demand. Would suggest in connection with your Reclamation of Material Committee that the subject be given careful consideration to the end that:

First.—All hose to be as small in size and short as possible consistent with the use it is to be put to. Check up car heating and washout plants particularly, as considerable saving can be made in some places.

Second.—Wire wound hose of less number of plys and at correspondingly decreased cost may often be substituted for special hose frequently used for withstanding high pressure.

Third.—Substitute lengths of iron pipe for hose wherever possible.

Fourth.—Discontinue the use of rubber mats and step treads in cars and other places where used.

Fifth.—Sheet rubber can often be replaced with composition packing at less cost and at same time conserving the supply of rubber.

Sixth.—Old rubber should be carefully collected and disposed of as scrap, promptly.

On account of the acute shortage of files, all worn files should be collected and where the facilities exist, resharpened, and when worn so badly they cannot be further resharpened, should be sent to file makers for recutting, and none scrapped until you are absolutely sure they cannot be further utilized.

Scrap.—On account of the shortage of iron and steel, the War Industries Board and the Council of National Defense call attention to the necessity for picking up and either selling or reclaiming every piece of scrap iron or steel, dismantled machinery, obsolete iron and steel material or machinery that can be found on each road.

The Railroad Administration directs that special attention be given this matter and all such metals and materials be disposed of to the best advantage as soon as possible.

Each road will please report to this office on or before June 30, 1918, what has been accomplished along the lines indicated above.

Equipment Exports from the port of New York in March, 1918, consisted of locomotives valued at $964,492, freight cars at $455,360, and steel rails at $305,198.—*Bulletin of the National City Bank, New York.*

A DECADE OF PROGRESS IN BUILDING STEEL PASSENGER CARS

In order to ascertain the progress of the building of steel and steel underframe passenger train cars and to develop the cost of reconstruction in steel of the present wooden equipment of the country the Special Committee on Relations of Railroad Operation to Legislation sent certain requests to the carriers on January 2, 1918. Replies were received from 434 roads operating 246,224 miles in the United States and 64,816 passenger train vehicles, and with 966 under construction on January 1. Replies were also received from eight companies operating 33,269 miles in Canada, with 5,422 passenger train vehicles, and with 35 under construction on the same date. Estimates and percentages in the tables apply only to cars operated by roads in the United States.

It will be noted that there were but five wooden passenger train cars constructed in 1917 and that but 27 such wooden cars were under construction on January 1, 1918, indicating that the building of wooden passenger train cars has practically ceased.

ANNUAL ADDITIONS OF PASSENGER EQUIPMENT

Acquired in	Total number	Percentages: Steel	Steel underframe	Wood
1909	1,880	26.0	22.6	51.4
1910	3,638	55.4	14.8	29.8
1911	3,756	59.0	20.3	20.7
1912	2,660	68.7	20.9*	10.4
1913	3,350	63.0	30.4*	6.6
1914	4,495	74.6	29.9*	4.5
1915	1,696	73.7	20.1*	6.2
1916	1,445	92.5	7.3*	.2
1917	2,780	62.5	37.3*	.2
January 1, 1918 (under construction)	966	90.8	6.4	2.8

*This figure includes wooden cars reconstructed with steel underframe.

The rapid increase in steel and steel underframe cars is shown below:

Approximately in service	Steel	Steel underframe
January 1, 1909	629	673
January 1, 1910	1,117	1,098
January 1, 1911	3,133	1,636
January 1, 1912	5,347	2,399
January 1, 1913	7,271	3,296
January 1, 1914	9,492	4,608
January 1, 1915	12,900	5,700
January 1, 1916	14,286	6,060
January 1, 1917	15,754	6,136
January 1, 1918	17,601	8,339
Increase 1918 over 1909	16,972	7,666
Per cent increase 1918 over 1909	2,698	1,139
Per cent increase 1918 over 1917	11.7	35.9

The number of wooden cars in service on January 1, 1912, was 48,126. There are now in service approximately 38,876, indicating the retirement from service of 9,250 cars in six years.

APPROXIMATE COST OF REPLACEMENT OF WOODEN CARS WITH CARS OF STEEL

	Number	Average cost*	Amount
Postal	158	$19,000	$3,002,000
Mail and baggage	2,236	17,500	39,130,000
Mail baggage and passenger	572	17,500	10,010,000
Baggage and passenger	3,205	17,500	56,087,500
Baggage or express	6,998	14,800	103,570,400
Passenger	20,727	23,000	476,721,000
Parlor, sleeping, dining	3,978	37,000	147,186,000
Business	726	26,000	18,876,000
Motor	276	35,000	9,660,000
Total	38,876		$864,242,900
Annual interest charge at 5 per cent			$43,212,145

*The cost figure is the same as used a year ago.

THE RAILWAY SHOP TOOL ROOM

One of the Most Important Departments. Its Efficiency Is Reflected Throughout the Entire Plant

BY M. H. WILLIAMS

IN many respects the tool room in a railway shop is one of the most important departments, the relative grade of work of the entire shop being largely influenced by the standards set by it. Moreover the ability to design and manufacture special jigs, fixtures, tools and appliances for economical manufacturing in the general shop will largely govern the cost of all work produced. Where the tool room sets a high standard of accuracy it will generally be found that other departments will eventually follow suit; but let the tool room become careless about tools manufactured, and workmen using the tools will get the "don't care" habit, the resultant poor work being evident throughout the entire shop. It follows, therefore, that the tool room instead of being in one corner, should be strictly in the limelight, and if anything, over-equipped for the work to be done.

Railway tool rooms are called on to manufacture a great variety of articles, probably as many as the tool rooms of many large manufacturing concerns. As illustrations, mention may be made of special taps, thread dies, reamers, gages, drop forging dies, forging machine dies, hammer dies, milling cutters, shear blades, punching dies and punches and a thousand and one special appliances. Many of these must be very accurate and should be equal to similar tools made by the best tool making concerns. This high grade and miscellaneous output naturally requires a very up-to-date equipment of machines and small tools and also suitable measuring instruments to properly measure and prove the accuracy of the tools manufactured.

One of the first requirements for the tool room is to be able to judge when a tool is made correctly, this referring to size, finish, hardness and general design. For the reputation of the railway, each tool manufactured should be equal in all these points to tools of similar class made by other manufacturers. No tool should be allowed to leave the tool room until it is correct in all respects. If this rule is well established, the tool room will receive the respect of the entire organization.

MICROMETER CALIPERS.

For measuring the various kinds of tools that are to be manufactured, it is a question if there is any tool better suited to the requirements than the micrometer calipers as regards accuracy and convenience to the workman. Certain standards may be considered desirable for reference gages in the larger shops, but for the average shop these calipers and the standard reference pieces generally accompanying them will meet most all reasonable demands. Micrometer calipers are expensive as compared with plain machinist's calipers and often at first appear difficult to use, but the workmen soon become accustomed to them. The result of their use is better workmanship, and fewer spoiled jobs, which will soon offset the cost of the calipers.

In these days, on account of the demand for expert workmen in manufacturing concerns, railway men who can caliper closely with machinist's calipers are on the decrease. With micrometer calipers a comparatively inexperienced man can caliper closer than an expert with hand calipers.

To meet ordinary requirements, the tool room should be supplied with micrometer calipers of sizes to suit the tools generally manufactured or required for the general shop. A set of outside and inside calipers varying by 1-in. steps up to 12 in. will generally be sufficient. These should not be considered exclusively tool room appliances but should be kept in a case or rack and given out on tool checks to men working on jobs in the general shop where the accuracy can be improved by close calipering. It is advisable where possible to measure and inspect each tool made by a man using micrometer calipers. This may look like an unnecessary refinement, but it will soon result in the workmen getting into the way of doing excellent work through knowing that their work is to be carefully checked.

There are a number of cases where micrometer calipers are essential and superior to ring gages, as in making reamers where the diameter should be slightly over size to allow for grinding after hardening. Taps should also be made a trifle large to allow for wear. All kinds of solid cutters for boring work, shafting, bolt sizes, gages, arbors, piston rods, valve stems, car axles, etc., should be tested for size by micrometer calipers. In the case of piston rods, the necessity is well understood of grinding or finishing them to one diameter for the entire length of surface passing under the packing, to prevent wear in packing and steam leaks. With micrometers the size of the rods can be measured at various places and the variation, if any, ascertained in exact thousandths of an inch. A limit can be set to govern the amount these rods may vary and .004 in. is recommended as satisfactory and not difficult to maintain. If this is established, all rods coming within this limit would be

accepted and used. Rods not finished within the limit should be corrected. The workmen will then know just what is expected and can work accordingly. Solid gages cannot be used on piston rods on account of the many different diameters.

For fitting crank pins and axles into the wheel centers, micrometer calipers can be used to good advantage. In this case the hole is usually measured with inside micrometers and the axle or pin machined a few thousandths of an inch larger. The amount allowed will vary with different metals and the results will be much more uniform than with the older practice of using machinist's calipers and making allowances for force fits according to each man's judgment.

Micrometer calipers are almost indispensable for the miscellaneous force and for shrink and running fits such as the tool room is called on to make; for instance, turning new shafts for cranes, motors or machine tools. In many cases the defective shaft can be calipered and a drawing made of it, which will enable the new shaft to be machined to the exact size required without throwing the crane, motor or tool out of service except for a very short time. Where the size of the shaft required is known to the thousandths of an inch, there is absolutely no reason why a new one cannot be made to fit perfectly. This is well illustrated by the way repair parts for automobiles fit.

THREAD MICROMETERS

In most cases railway tool rooms are called on to manufacture a number of odd sized taps, threaded pieces, thread gages, etc., peculiar to the road on which they are located. The drawings for these generally specify the diameter, threads per inch, and the form of thread, such as United States, sharp V, Whitworth, etc. Where these drawings go to several shops, there is always the possibility of the taps or parts not being interchangeable and not fitting properly unless some reliable standard is followed. Should standard gages be made at one shop and distributed to other shops they would be expensive and there is always the possibility of losing gages that are used only occasionally.

It is recognized that a thread to fit properly must have the correct outside diameter, pitch diameter and thread shape and for accurate testing thread micrometer calipers

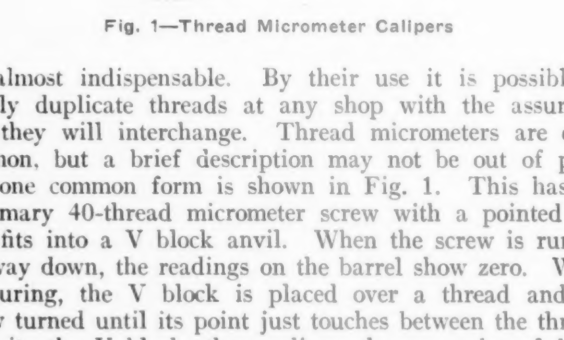


Fig. 1—Thread Micrometer Callipers

are almost indispensable. By their use it is possible to exactly duplicate threads at any shop with the assurance that they will interchange. Thread micrometers are quite common, but a brief description may not be out of place and one common form is shown in Fig. 1. This has the customary 40-thread micrometer screw with a pointed end that fits into a V block anvil. When the screw is run all the way down, the readings on the barrel show zero. When measuring, the V block is placed over a thread and the screw turned until its point just touches between the threads opposite the V block, the readings shown on barrel being the pitch diameter of the thread measured. Tables showing the amount the pitch diameter should be smaller than the outside diameter generally accompany the micrometers and are readily understood.

For the average railway tool room thread micrometers for measuring all threads up to 2 in. diameter will generally meet the requirements. For larger threads a choice can be made of purchasing larger thread micrometers or using the so-called three-wire system by which plain micrometers and wires are used. A description of this system is fully shown in text books.

The following two uses of thread micrometers will serve to illustrate their value. When making taps it is generally considered good practice to make them slightly over size so that the hole tapped will be a trifle large to allow the bolt to fit freely. This oversize may vary from .002 to .006 in. or more, as the case may be. With the use of plain micrometers, the outside diameter can readily be measured for any desired over size and the pitch diameter can likewise be measured. With these two dimensions correct, the flat surfaces at the top of the thread will also be correct. Assume that a 1-in. staybolt tap is desired .004 in. over size, 12 threads, U. S. form thread. The outside should be 1.004 in. and by consulting a catalogue or text book it will be found that for 12 thread U. S. form thread, the pitch diameter should be .0541 in. less, or 1.004 in. minus .0541 equals .9499 or practically .950 in., to which size the tap should be threaded.

When making taps there is always the possibility that they will change size when hardening, generally enlarging. For a 1-in. tap this may amount to .001 in, or more, depending on the grade of the steel. Allowances can be made for any variation expected as a result of hardening, which would be very difficult by other methods.

The tool room is often called on to make a sample thread or gage for a globe valve, say 1½ in., 10 U. S. form thread. In this case the pitch diameter for 10 U. S. form thread is .0649 in. less than the outside diameter or 1.500 in. minus .0649 equals 1.4351 in. Finishing the outside to 1½ in. and chasing the thread to a pitch diameter of 1.435 in. will insure a gage or thread of correct size and one that will be interchangeable with any other piece made to the correct size. Thread micrometer calipers can be recommended for use on every threaded article made in the tool room.

THREADING TOOLS

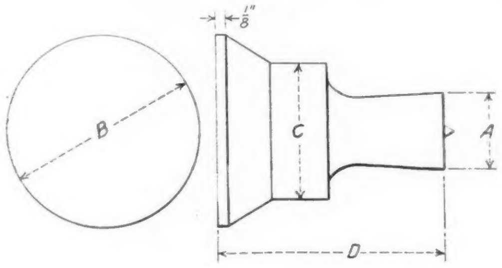
The threads that it is necessary to cut in the tool room should be as accurate as possible. As well known, it is a difficult operation to grind a lathe tool to the correct shape and angle for this purpose. The general appearance and accuracy of the threads will in most cases be improved by the use of the special threading tools sold for this purpose by a number of concerns. These tools have the bits or chasers ground with great accuracy by special holding appliances and will be found as a general rule more correct in form than tools made from solid steel with the average grinding. Such tools can be sharpened by grinding on the top surface and without altering their form. All things considered, they will be found cheaper in the long run than solid tools. For this reason and the improvement in workmanship, they should be introduced in the tool room and can be used to advantage for any lathe threading.

MILLING CUTTERS

On account of the many varieties of milling cutters used in railway shops no attempt will be made to describe their manufacture in detail but it is well to bear a few points in mind when special cutters have to be made.

Always bore the hole about 0.010 in. smaller to allow for grinding after hardening, or for an inserted tooth cutter with unhardened center, the hole should be ground. The hole and one hub end should be ground at one setting to insure the end running true. The second end after grinding

should be calipered with the first end in order to be sure that it is true and parallel. The size of the hole should be calipered with a plug gage and made correct to size as nothing is more annoying than a cutter that does not fit the arbor properly. In cutting the keyway, avoid sharp corners at the bottom, as they are liable to cause a crack when hardening. Also for the same reason, sharp corners should be avoided at the bottom of a tooth. Cutters should be ground on the face of the tooth as well as the outer edge. Cutters for wrought iron or steel work are better if the teeth are undercut or given about 10 deg. rake on the front face. A cutter with teeth spaced 1 in. to 1¼ in. will cut as smoothly,



A		B	C	D
Min.	Max.			
1/8"	9/16"	3/4"	19/32"	1 1/2"
5/8"	1"	1 3/16"	1 1/32"	1 15/16"
1"	1 3/4"	1 11/16"	1 25/32"	2 9/16"

Fig. 2—Only Three Sizes of Boiler Punch Heads Needed

last longer and do more work than a cutter with teeth spaced ¼ in. to ⅜ in. Cutters should be sand blasted after hardening, which improves their appearance and the smoothness of the surface. The make and grade of steel should be stamped on cutters for future reference and re-hardening; also the designating name or mark of the shop.

BOILER PUNCHES AND DIES

The tool room can without doubt save considerable expense to the general shops, and help out the boiler shop by standardizing a number of small tools such as boiler punches and dies. It is important that a stock of these be kept on hand of the sizes generally used, so that punching machines may not be held up. If the punching presses in the local shop or in the various shops on the system have different designs of holding nuts or clamps for holding the punch, it may often happen that special punches will be required for each press. That is, it may be necessary to make two or three designs of 9/16 in. punches.

By carefully studying conditions it will generally be found that the various punching machines can be altered and new holding nuts made so that one style of punch will be common for any punching machine on the road. For railway work it is necessary to change the sizes of punches and dies frequently. Therefore, the number of sizes of heads should be reduced to reasonable limits so that it will not be necessary to provide too many holding nuts for the punching press rams. On the other hand, if the steps in sizes are too great, it will make it necessary to make some of the punches with a small cutting edge and a large head, which is a poor design and requires a large amount of tool steel for the size of hole to be punched. Fig. 2 shows the form of punch made by a number of concerns that meets the requirements very well. The table of sizes is offered as a suggestion. It calls for three punches and covers all diameters generally required for boiler, tank and steel car work.

In order to hold these punches in existing punching machines it may be necessary to make new holdings nuts for the rams. One design is shown in Fig. 3 *A* being the nut, which is generally made hexagon, *B* the punch, *C* a filler block and *D* the ram of the press. Attention is called to the filler block *C*. It is desirable that the end of any length of punch shall extend the same amount from the end of the press ram to avoid changing the stroke of the ram of the press. By making the punch and filler block together to equal one length for any length of punch, will eliminate the necessity of adjusting the stroke of the press. The nut as shown in Fig. 3 would have to be made with the thread suitable for each design of punching machine. It is desirable to make a separate nut for each size of punch head generally required.

Fig. 4 shows a form of die used quite extensively. In order to accommodate this die it will in some cases be necessary to rebore the die block. The bore should be of a size suitable for the largest die generally used on the punching press on which the die block is used. The smaller dies can be used in the same hole by the use of filler cups as shown in Fig. 5. This cup should be made of sufficient thickness at the bottom *A* to insure the tops of all dies being the same distance above the die block.

By following the method as outlined above any punch or die may be used in any punching machine. This will reduce the number of parts to be kept in stock and will meet the requirements better than a large variety of shapes and sizes.

For punching holes in angle irons or to meet special requirements, it may be necessary to make longer punches or higher dies. These, however, can generally be made with the same sized bodies and to fit the same holders.

Dies are at times made with a flattened side for a set screw to rest against for holding in the die block. With dies made correct to size this cannot be considered necessary, as a die will rarely lift in the die block. The set screw may be an advantage to prevent the die turning or coming loose. However, this is a question.

It is very essential that punches and dies be made correct to size and true, so that in the event of removing either it shall not be necessary to readjust the die block to line up with the punch. Generally the hole in the die block should be about .003 in. larger than the nominal size of the die, and the dies should be made to the nominal diameter to

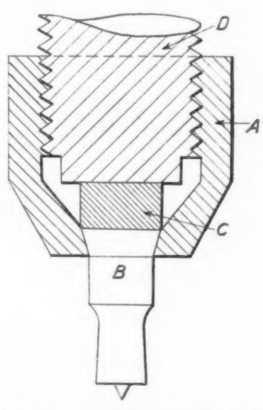


Fig. 3—Boiler Punch Holding Nut Arrangement

about .005 in. less. The punch should be true and the top surface square with the body to prevent throwing the cutting edge out of line and necessitating a readjustment of the die.

SQUARE WRENCHES AND SOCKETS

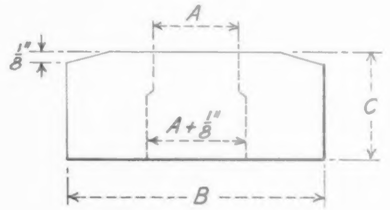
One annoying problem is that of keeping up the supply of wrenches, air motor sockets, etc. necessary for driving staybolt taps, reamers and applying staybolts. This is aggravated by the variety of sizes required. If the number of these sizes can be reduced, the conditions will be improved both in the tool room and the rest of the shop. For example, the square shank on a ⅞-in. staybolt tap is generally made 9/16 in. These taps do not require a great amount of power to drive

and as they do not bottom they do not receive the abuse incident to bottoming. Without a doubt staybolt taps of ⅞-in., 15/16-in., 1-in. and 1 1/16-in. can all be made with 9/16-in. square shanks, and the 1⅛-in., 1 3/16-in., 1¼-in. and 1 5/16-in. can have ¾-in. shanks without affecting their strength. By this plan two sizes of wrenches and sockets will be suitable for eight sizes of taps, as compared to eight, and the elimination of six sizes of sockets and wrenches. Also, where it is the practice to square the ends of staybolts and the head of button head or crown staybolts for screwing into the boiler, they can be made to one of these sizes. By this method one wrench or motor socket can be used for the larger majority of staybolt work. This will not only reduce the number of sizes of wrenches and sockets required, but when the workmen are on the boiler it will not be necessary to carry along a number of sockets. Another good result is that the proper sized socket will be used and thus reduce danger of accidents on account of wrenches slipping off the taps or bolts.

FORMS OF THREAD OF STAYBOLT TAPS AND STAYBOLTS

Three forms of thread are used by railways for staybolts, namely, the sharp or V thread, the United States form and the Whitworth. It would hardly come within the province of the tool room to decide on the form of thread to be used, and no recommendation will be made in this article. The peculiarities of the different forms will be considered from a tool room point of view.

There are no well recognized standards of pitch diameter size for the V form of thread. While gages have been made by some of the leading tool concerns, they are not theoretically correct and not guaranteed to be so by the makers. To cut this thread to correct pitch diameter would make the top of the thread as sharp as a knife edge, which is not practical. As a matter of fact, staybolt taps of V form of thread are generally made from .012 to .018 in. larger at the pitch line than the theoretical size. On account of the difficulty of maintaining a standard for the V form of thread, it would be well for the tool room to get away from its use if possible.



A Min.	A Max.	B	C
1/8"	1/2"	1¼"	1⅛"
9/32"	7/8"	1½"	1⅛"
1"	1½"	2 15/16"	1¼"

Fig. 4—Boiler Punch Dies Reduced to Three Sizes

United States standard form of thread is used almost exclusively in the manufacture of bolts, and the same form of thread, known as United States form (or U. S. F.) can be used to good advantage for staybolts. A very simple formula is given for the pitch diameter for any number of threads per inch, as follows: Pitch diameter $= D - \frac{.6495}{N}$, in which D is the diameter of the bolt or tap, .6495 a constant and N the number of threads per inch. For 12 threads per inch, as largely used on staybolts, the pitch diameter will be practically .054 in. less than the outside diameter, or a 1-in. bolt should have a pitch diameter of .946 in. This form of thread has many advantages from the tool room standpoint. It is not hard to cut, can readily be measured with the thread micrometer caliper, and by establishing a limit governing the amount a staybolt may be under size or the tap over size, the bolts and taps can readily be made to interchange.

The Whitworth thread differs from the U. S. form on account of the rounded top and bottom of thread, and has a 55 deg. included angle instead of 60 deg., as used with the U. S. F. The pitch diameter is calculated by formula $D - \frac{.640}{N}$, and for 12 threads the pitch diameter is about .001 larger than the U. S. form. The objection to this form

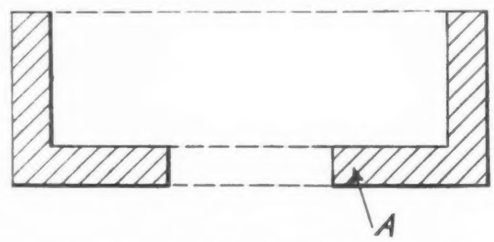


Fig. 5—Filler Cup to be Used With Boiler Punch Die

of thread from a tool room standpoint is that of cutting the rounded top and bottom of the thread, which should require a special ground tool for the purpose.

Boilermakers have discussed the question of the form of thread to be used from a number of angles, and there are no doubt advocates in favor of each form. As a matter of everyday shop practice in cutting staybolts, it is a question if threads cut to any of the three forms will vary enough to be noticeable. The flat surface at the top and bottom of the thread on a 12-thread U. S. form bolt should be .0104 in., or about .01 in. Examine a rule graduated to 1/100 in., or, if not handy, a rule graduated to 1/64 in., and observe how small an amount this is. A slight dulling of the dies or chasers used to cut the bolts will remove the sharp corners of the U. S. form of thread and cause it to resemble the Whitworth. Also a slight dulling of chasers when cutting the V thread will cause it to appear the same as the two forms mentioned. Or, in other words, in the every-day practice of cutting staybolts on bolt-cutting machines, by the present methods, the condition of the chasers or dies will govern the form of the thread selected. The U. S. form has the advantage of well defined sizes and formulæ, and is as easy to cut as any. Dies or chasers are easily maintained. It would also probably be easier to maintain the standards than with other forms. The latter will be an advantage to a tool room that is called on for tools in connection with staybolt work.

THREAD GAGES

The question of always having proper fitting bolts is very important in railway work, and in order to obtain interchangeability it is essential that a system of gages be provided for the workmen when cutting bolts. Ring and nut gages have been used for the purpose, but they are not all that is desired, on account of the time required to try on to a bolt.

For the general run of bolts such as are required for railway use, the thread gage shown in Fig. 6 answers very well. This can be obtained from a number of gage-making concerns. As will be noted from the illustration, it has two pairs of adjustable points, each of the same angle as the thread to be measured. The top pair is set to the maximum size of the pitch diameter allowable, and the lower set to the minimum size. This makes a "go" and a "not go" gage. The points can readily be adjusted to compensate for wear and to meet a reasonable amount of tolerances. With this form of gage, bolts can be tested with sufficient accuracy for the average

railway work, and on account of its ease of operation the workmen will make more frequent use of it than the ring gage. It is particularly useful when setting dies to the proper size, but will not detect a bolt out of pitch; that is, not having the correct number of threads per inch. This must be ascertained with screw pitch gages. Master gages, which can also be obtained from the manufacturers, must be provided for setting shop gages. One cheap form that answers very well can readily be made as shown in Fig. 7. This gage is threaded taper about ½ thousandth per thread, or for 12

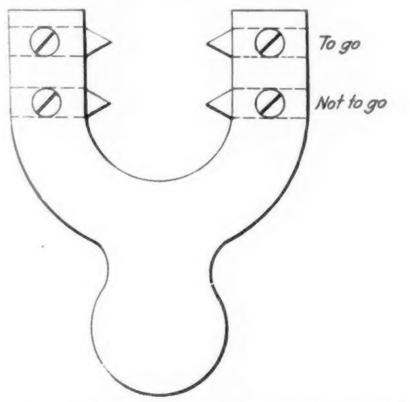


Fig. 6—A Convenient Form of Adjustable Thread Gage

threads per inch .006 in. taper per inch. It should be three to five inches long, depending on the pitch of the thread, and about ¼ in. thick. After hardening and grinding the sides, the thread sizes, both maximum and minimum, can be ascertained by a thread micrometer by calipering the various threads until sizes required are selected. Arrows or indicating marks to show the correct position on the gage can then be ground or etched on the flat surface.

The work thread gages should be proved or adjusted to the test gages frequently, depending on the extent to which they are used. It is advisable to seal the work gages when set, to prevent tampering with same.

The amount of tolerance to be allowed when cutting bolts and tapping nuts has not been well defined. The Ordnance Department of the United States recommends the following for close fits:

Number of threads	Bolt	Nut
4—6	+0.000	—0.000
	—0.008	+0.008
7—10	+0.000	—0.000
	—0.006	+0.006
11—18	+0.000	—0.000
	—0.005	+0.005
20—28	+0.000	—0.000
	—0.004	+0.004

All referring to pitch diameter.

These tolerances, it is believed, are no closer than necessary for railway work, and if the work gages for bolts explained above, are provided and used, the bolts manufactured will be interchangeable, and trouble from improperly fitting bolts and nuts will disappear. A bolt cut to minimum size and a nut tapped to maximum size will make a loose fit. However, this does not happen often in practice.

The principal trouble when threading on the average bolt cutting machine, the point or first part of the thread is generally smaller, owing to spring in the die head. By gaging about one inch back from the point, a general average will be struck that will satisfactorily meet all the requirements for bolts used on locomotive and car work.

STAYBOLTS

For staybolts it is generally advisable to provide work and setting gages for each size of bolt to be cut. The limits for this work should be fairly close, and it may require a few trials to determine the amount of tolerance necessary to meet the demands of the boilermakers and avoid too close work on the part of the bolt shop. A limit of .004 in. below the theoretical size will not be found difficult to cut and will give good results. It follows that a 1-in. staybolt must be cut between the theoretical pitch diameter of .496 in. and the minimum size of .941 in.

The work gages and also the setting gages would have the following pitch diameters for U.S.F. threads:

Bolt size	Pitch diameter Maximum	Minimum
⅞ in.	.821 in.	.817 in.
15/16 in.	.882 in.	.878 in.
1 in.	.946 in.	.942 in.
1 1/16 in.	1.008 in.	1.004 in.
1⅛ in.	1.071 in.	1.067 in.
1 3/16 in.	1.133 in.	1.129 in.
1¼ in.	1.196 in.	1.192 in.

It is sometimes advisable to make the thread on the head or button end of crown bolts larger than the theoretical size, and in this case it may be desirable to set a limit of theoretical size to .004 in. above, in order that the bolt will screw tight into the boiler sheet.

MACHINE TOOLS FOR THE TOOL ROOM

Machine tools such as lathes, shapers, drill presses, universal and other grinding machines are too well understood to require special mention, and attention will be called only to a few features desirable for railway work.

Lathes.—It is a good plan to have at least one lathe equipped with a backing off attachment, which is useful when making formed or special milling cutters and also for relieving taps. Machine relieving is generally preferred to relieving by hand, and also gives a neater appearance.

Shapers.—The conventional shaper is a useful machine for tool rooms. However, too many should not be installed without carefully considering the relative merits of milling machines and surface grinders. The latter machines are often better adapted to certain kinds of tool room work.

Milling Machines.—The universal milling machine with index head, is indispensable for railway tool rooms. However, after one or two have been installed, it is advisable to consider other forms when increases in tool equipment are necessary. The large majority of tools, such as taps, reamers, dies, flue tools, etc., are milled without setting the table on an angle, and where a plain milling machine costing less will answer so much the better. The plain machine has the advantage of being more rigid, and heavier cuts may be taken, which will result in greater output. With the plain machine it will often be found that flat surfaces

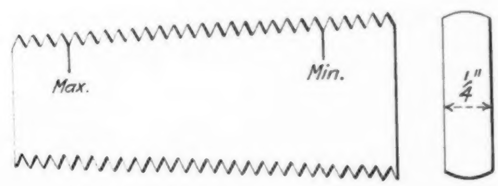


Fig. 7—Hardened Master Thread Gage

like die blocks for bolt headers, drop dies, blanks for bolt chasers, etc., can be milled quicker than shaping or planing.

For working out the depressions in drop forging dies, special form hammer dies, punching press dies of special shapes, forging machine dies, and precision drilling and machining odd shaped articles, the vertical spindle knee type milling machine or the so-called drilling and milling machines can be used to good advantage. With machines of this nature many jobs can be milled that are now chipped. This class of machine can also be used for flat surface milling, by the use of face mills.

Grinders.—Most tool rooms are equipped with universal grinding machines, and these are too well understood to require comment. On account of the increasing use of spiral

milling cutters, both solid and inserted tooth, it is advisable to have one machine equipped with the special grinding attachment. This attachment may be used for grinding the face of the tooth of cutters. This will improve the cutting qualities and also reduce the time between grindings. With this attachment, the flutes in worn cutters can be ground deeper, and also when desirable to change the shape of the tooth, this can readily be done. This will at times eliminate annealing and rehardening.

For the larger tool rooms the plain cylindrical grinder can be used and effect considerable saving. It is a production machine and has the necessary strength and weight to remove metal quickly. For a number of jobs it will be found that grinding is quicker than turning and filing. Work such as arbors, shafts for motors, cranes and machine tools, drifts, round shanks of reamers and taps, etc., can be ground very quickly and with great accuracy. One good practice is to turn the shaft about 1/32 in. large with coarse feed and finish on the grinder. In many cases where only a small amount of reduction in size is required, say 1/16 to 3/32 in., the piece can be ground direct from the rough bar much cheaper than turning. One good use for the cylindrical grinder is that of grinding the round shanks of reamers, taps and similar tools after hardening. This improves the appearance of the tools, and as the turning can be done in a rough manner, the grinding will not add to the cost of the tool. With one of these machines installed, new jobs will be found for it, so that it will not be idle. It will to a large extent take the place of a lathe and also relieve the universal grinders.

Surface Grinders.—The surface grinding machine is used only to a limited extent in railway shop tool rooms. It is, however, useful and economical for a large number of jobs. There are four general types, namely, the vertical shaft type with rectangular reciprocating table, the vertical shaft type with circular rotating chuck, the horizontal shaft type with rectangular reciprocating chuck, and the horizontal shaft type with circular rotating table. All of these can and should be provided with magnetic chucks. Each has its uses. The vertical type machines, which generally are equipped with ring or cup grinding wheels, will, under most conditions, remove metal faster than the horizontal shaft type, and may be considered largely production machines, which can be used for the tool work and also for a number of locomotive parts. The horizontal shaft machines are somewhat more general in their application for tool room work, but not as well adapted to locomotive work.

With the vertical shaft types a number of jobs can be ground cheaper than planing, and made more smooth and accurate. For example, work such as die blocks for bolt headers and gripping dies, if forged fairly close to size, can be ground from the forging quicker than planing. Steel used for chaser dies, boring bar cutters, double end cutters for boring car brasses, and cutter bits for various boring operations can be ground directly from the bar steel. In addition, a number of locomotive parts can be ground to good advantage, such as rod wedges, crosshead keys, slide valves, slide valve strips, etc. If forged or cast fairly close to size they can be ground quickly, and on the larger types of rectangular machines, locomotive guides and ends of main and side rods may be ground.

The horizontal shaft type with reciprocating table can also be used on the tools mentioned above, and in addition can be used for form grinding, such as the grooves in bolt or rivet header dies, and work of similar nature, on account of being provided with radius truing devices, by which the grinding wheels may be trued on the periphery to any half-circle desired. A machine equipped to grind the grooves in bolt and rivet header gripping dies will prove very useful, the method followed for new dies being to mill or drill the grooves a trifle small and grind to the proper size. Also when the dies become worn from service they can be refinished by grinding a new flat surface and regrinding the grooves. This will eliminate annealing the dies when hardened steel is used, and for soft steel it will generally be found quicker than other methods. The customary method is to set the two halves on a magnetic chuck and grind both at once. The half-round grooves can be ground in about 30 minutes, including the time of changing and truing the wheel.

Surface grinders can be used to sharpen hardened punches and dies used for punching various odd-shaped pieces. By keeping these sharp, the appearance of the punchings will be improved and the dies will last much longer. They can also be used to grind the flat surfaces of gages, straight edges, parallel strips, sharpen shear blades, face sides or surfaces of bolt chasers or dies, finish the surfaces of cutting tools used in all forms of tool holders, and a large number of special appliances. This finish will be obtained very much quicker than by hand polishing and will have a much better appearance.

HARDENING AND TEMPERING

Furnaces for hardening and tempering need no description here. As far as possible, all tools should be hardened and drawn according to pyrometer readings. While it is true that a number of the tool hardeners in railway shops become very expert in judging heat by the eye, the fact remains that the conditions can be much improved by the use of pyrometers.

A record of each tool, or batch of tools hardened at one time will be found of value in the tool room. It should specify the kind of tool, make and grade of steel, degree of heat when quenched and kind of bath, degree of draw, time in hardening furnace, scleroscope hardness and any peculiarities. This record can be kept in a book, or better still on a card index. In the event of the tool not wearing properly or breaking, the record can be referred to, and proper modifications made for future tools, or should the tool wear well, the record will be a guide for future heat treatment.

THE SCLEROSCOPE

As a means for obtaining a uniform degree of hardness of tools the scleroscope is now being introduced into tool rooms, and the principle on which it operates is as follows: A small weight is dropped inside of a glass tube on the object to be tested, and rebounds, the amount of rebound being governed by the hardness of the object, and read on a graduated scale.

When testing soft steel with the scleroscope, the rebound may be 20 to 40 on the scale. For tools hardened to stand shocks, like chisels or flue tools, it may be 55 to 65, and harder tools, such as taps, may show 70 to 90. Practice with this instrument on tools that have given good service, will quickly enable any shop to set a standard for hardness that may be followed for tools manufactured.

When tempering tools there is always a possibility that they are not hardened to the proper degree, and even when a batch are hardened at one time some may be too soft or too hard. By testing each tool the hardness can be ascertained, and any not correct may be retempered. This will eventually result in a great improvement in the grade of tools manufactured. The amount of time required to test with this instrument is very small.

This article calls for a number of refinements not usually found in railway tool rooms, and at first glance some of the practices and appliances may appear out of place for tools used for locomotive and car construction and repairs. However, no tool or method is mentioned that is not common to most of the leading tool making companies. These companies are in the business to make money and naturally will not go into refinements if they do not pay.

Expedite Locomotive Repairs

A Well Knit Organization and Adequate Tools and Facilities Are Necessary in Shops and Engine Houses

BY GEORGE W. ARMSTRONG

WHILE the railroads through the spur of necessity have always been attentive to means for improving shop efficiency and output, there never has been a demand so insistently imperative as that which the country now makes that there shall be greatly increased efficiency in this and all other railway activities. An extra day spent in getting the shop work done on a locomotive or a few unnecessary hours' detention at the engine terminal, while seemingly of little moment, may be the indirect cause of losing a battle on the French front.

Every possible effort must be directed toward securing greater output per man, per machine, per pit and per shop. All must perform their parts in the great drama now being enacted, and the searchlight of improvement must be piercingly directed that every available facility shall produce its maximum.

In solving the problems of improved efficiency in mechanical department operations, two phases must be investigated which involve in the main different solutions, namely, the back shop and engine house.

The essential factors affecting general shop efficiency are:

1. Advance information as to repairs required.
2. Organization.
3. Scheduling and routing.
4. Material handling.
5. General shop equipment.
6. Centralized production.
7. Effective co-operation between mechanical and stores departments.

Similar factors relating to the engine house are:

1. Prompt movement of the engine to the engine house.
2. Through attention to minor defects.
3. General shop equipment.

One of the greatest aids in securing expedited repairs to locomotives in the back shop is the preparation of thorough advance information as to the repairs required, and while this practice is employed at present on a good many roads, it often has gradually degenerated to the mere perfunctory filling out of the necessary forms, and, therefore, does not accomplish the purpose intended. Especially important is the knowledge as to whether new cylinders, wheel centers, driving boxes, fire boxes, extensive boiler repairs and other machine details are required. Properly used, this information would enable the shop to prepare a greater portion of this material, so that when the engine is finally received, it will only involve removing defective portions and replacing them with the new parts, which can be done while repairs are made to the minor details of construction.

The prime essential at the shop is an effective organization, and without an organization that is responsive, aggressive and which will co-operate in every respect to secure the common aim of quick repairs and increased shop output, all other provisions for efficient operation will be neutralized.

You may force, fight or drive work through a shop, but you can never hope to attain the maximum if good feelings do not exist between the helper, mechanic, foreman, master mechanic or superintendent. Harmony is the oil that overcomes friction—and yet harmony must not be secured at the expense of discipline, or "abandoning a shop to the men," in order to avoid possible war labor complications. Firmness tempered with justice must be the prevailing sentiment.

One fault often found in railroad shops is an overburdening of the supervision. Effective results cannot be secured if a foreman or gang leader is not able to keep in touch with his men. The least frequently that he should see every man under his jurisdiction is every hour. The size for an effective unit organization will depend solely upon local conditions and the nature of the work. Obviously a blacksmith or machine foreman can supervise a larger body of men than one in charge of an erecting or boiler shop.

A scheduling and routing system* is absolutely necessary to secure expedited movement of parts requiring replacement or repairs and to insure prompt overhauling of locomotives. Aside from its wholesome effect in this respect, it is an excellent indicator of the essential degree of cooperation existing in the organization and will do much to bring the laggard into line. Scheduling and routing material relieves the individual foreman of the necessity for hunting and chasing material, thus affording greater opportunity and effective supervision of work. It keeps material moving, reduces delays and insures expedited output.

The results of organized scheduled effort have been demonstrated at various times in the past by record overhauling of locomotives in the various shops. While the experienced mechanical official realizes that back shop repairs made in from 20 to 36 hours are extraordinary results, still they are conclusive demonstrations of what can be effected to a lesser degree by utilizing the same implements, namely, thorough advance information as to the repairs required, cooperative effort, planning and scheduling of details.

Material handling undoubtedly offers one of the great-

*See the *Railway Mechanical Engineer* for August, 1913, page 423.

est obstacles at the present time in efficient shop operation. Unusual industrial demands to a great extent have absorbed the common labor, and what little is still to be found in railroad shops is extremely expensive, being mostly inexperienced help and commanding wages upon a par with that paid to mechanics prior to the war. Considerable thought, therefore, should be given to the utilizing of mechanical features as far as possible. While in a good many shops overhead cranes assist in handling of material from machine to machine or department to department, there is considerable hand trucking still necessary. A substantial saving can be made, not only in cost of handling this material through the shop, but also in the size of the force required by provision of floors and walks smooth enough to operate electric trucks, preferably those embodying an elevating feature, so that the work is delivered to the machine on a portable platform, removed from it to a machine and replaced by the machine operator after the work is completed and requiring simply to be lifted by the motor truck and readily transported to any point in the shop.

Another feature of the material question which should be investigated is the possibility of securing material from the storehouse for use at various points in the shop without the necessity of men leaving their work to go to the storehouse. This can be secured by reasonable anticipation of their wants and the installation of a messenger system, which can be developed in connection with motor truck operation as mentioned above. Orders for material may be left at different points in the shop, collected hourly and material delivered by motor truck despatch to the place required. A large loss in connection with the average shop operation is the waste through loafing to and from the shop and storehouse.

Another large factor requiring investigation at the present time is the necessity for better shop equipment. Size of equipment units have increased enormously, and in the greater portion of our shops no improved facilities have been installed to handle the larger units. Shops which were adequate for handling equipment averaging 200,000 lb. in weight are seriously overtaxed when required to repair modern Santa Fe and Mallet type locomotives, averaging from 350,000 to 500,000 lb. in weight. Machine tool facilities must be increased as well as erecting shop facilities, as not only are the parts in themselves larger, but the machine of today is vastly more complicated and requires more machining than the light consolidation of a decade ago. Not only has the equipment not kept abreast of the increase in size of power, but it has fallen behind the progress made in machine tool design and operation. Machine tools have been developed which will replace a number of lighter tools designed often solely to withstand the strains induced in using carbon steel tools. The draw cut shaper will largely increase driving box output and in itself perform the work formerly requiring a boring mill, planer and lathe. The vertical turret lathe will more quickly perform work usually done on a boring mill and in a good many instances replace a lathe, considerably reducing the set up time as well as the machining time.

Automatic machines have their possibilities also in connection with a locomotive shop, although unless the shop has a large output their use will not be warranted except in connection with centralized production for use at a number of shops and roundhouses. Set screws, studs and a large variety of similar parts can be cheaply finished on either single spindle or multiple spindle automatic screw machines.

The automatic chucking lathe is unexcelled for the manunfacture of oil cup covers, grease plugs, tank hose nuts, air pump piston heads and a great many similar parts. Much cutting off of stock is done in connection with finishing in turret lathes where the installation of an inexpensive automatic power hack saw will reduce the time and expense required in turret lathe operation, and due to an automatic chucking and feeding feature in duplicating stock of exact length, requires simply attention to insert a new bar.

One of the greatest aids to prompt turning of power at terminals and a big assistance in shop output is centralized production* of material capable of being finished partially or wholly in stock quantities. Its possibilities are large and its savings commensurate where a railroad has two or more shops and a number of outlying roundhouses. A constantly available supply of crosshead pins, knuckle pins, packing rings of various kinds, piston valve parts and bushings, oil cup covers and grease plugs, motion work pins, cab fixtures and numerous other things available for instant use at shop or roundhouse, the latter especially, often means the difference between a few hours or many hours delay in returning power to service.

Closely and intimately allied with centralized production is standardization of locomotive details.† While the development of efficient power requires adapting to operating conditions, a necessity precluding effective standardization of equipment, it is still possible and expedient to standardize details so as to result in reduction of material required in stock, enable quantity production of parts and insure prompt repairs.

All the good, however, accruing from the above factors will be nullified if there is not effective co-operation between the mechanical and stores departments. Material should be at hand in ample quantities to insure its availability when required, and yet not result in a surplus which is apt to deteriorate or become obsolete before used. An inspection of a good many casting platforms will reveal castings so badly rusted as to be unfit for use—castings which have become obsolete and for classes of power having a small number of engines operating over several divisions, an unwarranted surplus of material for these particular classes.

The engine house presents a problem differing from the shop in that equipment must be kept in serviceable condition and yet maintain adequate power to meet traffic demands. The first essential in any terminal is the layout. Time available for necessary work is limited, and the best equipped engine house in the country is handicapped without a well arranged terminal. Everything should be subordinated to the one idea of locating outside facilities so that necessary inspection, fire-cleaning, sanding, coaling, etc., can be expeditiously completed and the engine delivered to the house with the maximum portion of layover possible available for the required repairs. In many places faults in original layout, restriction of location or available ground are such that the ideal cannot be secured, but in many cases inexpensive readjustments will often enable a closer approximation to the ideal.

Thorough attention and correction of minor defects has been often stressed in the past. The old adage, "A stitch in time saves nine" is fully applicable to terminal repairs. Repairs should be promptly made, and even though their completion may involve withholding power, the cumulative delaying effect will, in the majority of cases, be diminished by such laying in of locomotives.

Equally as important as the making of necessary repairs is the investigation and connection of cause and effect. Too often rod bushings are renewed when the fault is a pedestal shoe or wedge not properly set up or requiring lining. Valve stem packing has been frequently renewed when the fault was a bent valve rod.

And, lastly, attention must be paid to engine house and shop equipment. Small tools must be available in quantities to meet strenuous demands. Not so much fault, however, is to be found in this respect as in the matter of ma-

*See the *Railway Mechanical Engineer* for June, 1917, page 289.
†See the *Railway Mechanical Engineer* for October, 1917, page 541.

chine tool and handling equipment. Machine tools must be supplied the engine house if it is to properly and promptly return power, so that, except for heavy repairs, it shall be independent of the shop. While the practice of passing second hand machinery to the roundhouse is not to be encouraged, it is highly probable, however, that some of the demands can be met by equipment released through centralized production or the installation of intensive production machinery. In the main, however, terminal machine tool equipment must be of a more rugged construction, simple in mechanism and with a wider range of adaptability than that suitable for back shop operation.

LOCAL STRESSES IN BOX BOLSTERS*

Tests of Loaded Bolsters with Berry Strain Gage Showing Effect on Strength of Design Details

BY L. E. ENDSLEY
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THE stress developed in a cast steel side frame for freight cars was discussed in a paper read by the writer before the Pittsburgh Railway Club in February, 1915.† In that paper the stress was determined at different points on the side frame by means of the Berry strain gage, and this gage was also used in the investigation of box bolster stresses.

The Berry strain gage, shown in Fig. 1, permits the elongation of a one or two-in. gage length to be determined

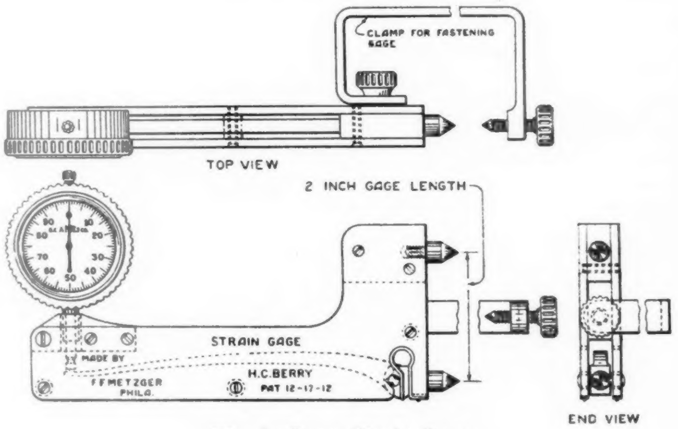


Fig. 1—Berry Strain Gage

to .0002 in. The dial of the gage is divided into 100 divisions. The movement of the hand between two of these divisions, which is approximately 1-16 in., is equivalent for cast steel to a stress of 2,700 sq. in. This was arrived at by determining the modulus of elasticity from test bars made of cast steel, which was found to be approximately 27,000,000.

METHOD OF LOADING

The method of loading for all of the bolsters tested, with the exception of one, is shown in Fig. 2. It will be seen that there are three points of applying the load, namely, on the center plate and on each side bearing. In the Pittsburgh Railway Club paper it was suggested that 220 per cent of the normal standing load would be a conservative figure to assume for the maximum direct vertical load coming on the side frame. The M. C. B. committee on Axle Design some years ago, assumed a horizontal load equal to four-tenths of the vertical load to act horizontally six feet above the rail. Assuming the center plate height to be 26 in. above the rails the maximum reaction on the truck spring for side bearing spacing of 50 in. for a 68,500 lb. static load and transverse load of four-tenths of the vertical, would be approximately 220 per cent of the normal reaction. For the purpose of these tests a car of 43,000 lb. weight with a capacity of 110,000 lb. was assumed, which gave approximately 68,500 lb. on the center plate with the car standing. Using 220 per cent of this load gives a force of 150,000 lb. on the entire bolster. In order to submit both ends of the bolster to the same stress as one would be subjected under the assumed load, the combined method of loading illustrated in Fig. 2 was used. This was done in order to get four readings on each bolster at the four equivalent points.

Bolster *H* was tested also under a center load of 68,500 lb., and bolster *I* was tested under a center load of 68,500 lb. only. This was done in order to take readings on top of the side bearings.

The results of tests on nine bolsters are included in this paper, all being of the box section and for 50-ton capacity freight cars.

It will be seen from Fig. 3 that bolster *A* has a curved bottom struck on a radius having the center on a line perpendicular to the center of the bolster, and due to the raised

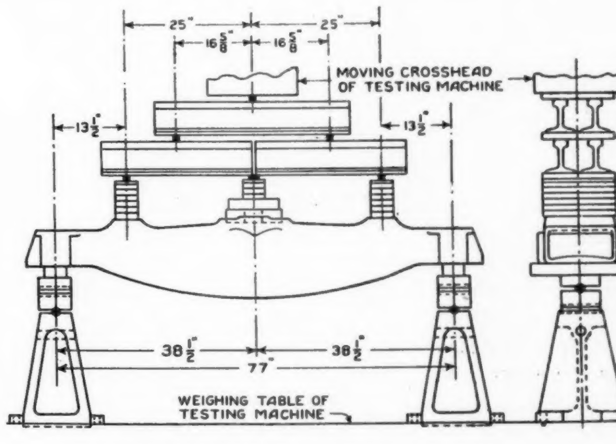


Fig. 2—Method of Combined Loading

side bearing, the metal in the top was not in a continuous straight line.

LOCAL STRESS DETERMINATIONS

Results obtained on bolster *A* are shown in Fig. 4. The numerical values given in this, as well as in all the remaining diagrams, give the stress at the points shown in pounds per sq. in. under the load shown on each diagram, which was 150,000 lb. for all tests but two. Where a minus sign appears before the number, the stress was compression. Those without this sign indicate tension. From a study of

*Abstract of a paper read before the St. Louis Railway Club, May 10, 1918.
†See the *Railway Age Gazette, Mechanical Edition*, for March, 1915, page 127.

these values at the different locations, which are the average of four readings at the equivalent points, it will be seen that the high stress points on bolster *A* occurred at the top of the bolster just outside and inside of the side bearing where the compression stress is 26,600 and 18,200 lb., respectively. The high stress here was due to two causes. The top of the bolster which is a compression member is not straight and thus tends to bend up at the side bearing and down at the curves on each side of the side bearing. This has the effect of causing a heavy compression stress on the inside of the concave surfaces. Furthermore, the center of the top member of the bolster can relieve itself by bending and the outside walls and edges close to the outside of the bolster have to do more than their calculated share, thus localizing the stress on the outside wall of the top member close to the end of these curves.

This is clearly shown by a study of the stresses on the outside wall on a line down from the center of the side bearing. Here it will be seen that the stress at the top of the side bearing is only 1,400 lb. in compression, advancing to 6,000, 7,100, 7,200 and 5,000 as the point of reading was lowered an inch each time, the maximum stress occurring at a point 3½ in. down from the top of the side bearing. The high stress point on the tension side of the bolster appears at the center of the bottom of the bolster just where the center plate support intersects the bottom of the bolster, where the stress is 15,900 lb. The next highest tension point occurs at the bottom edge 16 in. out from the center, where the stress is 13,400 lb.

The results obtained on bolster *B* are shown in Fig. 5. This bolster differs from *A* in that the holes in the top and bottom have been eliminated, and the thickness of these members increased 1-16 in.; holes were cast in the sides, as shown in Fig. 6, and the bottom member was cast straight instead of curved. The weight of the bolster was not changed.

It will be seen that the maximum stress point in the compression member is at the same place as in bolster *A*, but the stress is a little less—a maximum of 24,800 lb. being obtained just outside of the side bearing on the edge of the bolster. There is also a stress of 16,200 lb. compression on the outside of the small hole at the end. This hole was moved in 3½ in. in a bolster which is later described, and the stress around this hole reduced to a maximum of 3,400 lb. There are no high stresses around either of the other holes. These holes are placed in the bolster partly for the foundries' benefit in order to hold the cores and to relieve shrinkage stresses. Shrinkage of the metal in some cases causes cracks to develop. They also lighten the bolster and make a more economical design.

The stress in the tension member of bolster *B* is considerably less than that in the tension member of bolster *A*, the maximum stress being 11,100 lb. on the bottom of the bolster on a line underneath the center bearing support, with no other point above 11,000 lb.

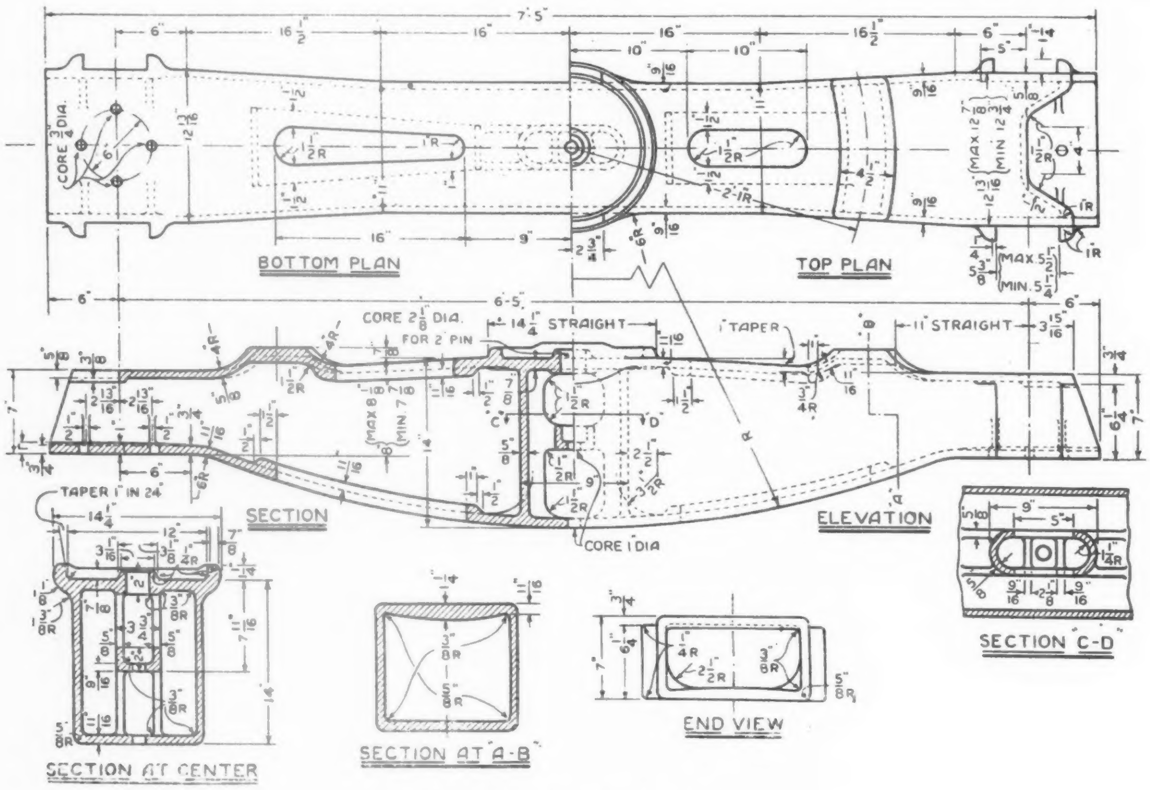


Fig. 3—Details of Bolster "A"

The results obtained on bolster *C*, which is exactly like bolster *B* except that two 5/8-in. ribs extend lengthwise underneath each side bearing are shown in Fig. 7. The stress in this bolster is almost the same as the stress in bolster *B* except that the maximum in the compression member has dropped down from 24,000 lb., to 19,000 lb. The tension member stresses run almost the same.

The results obtained on bolster *D* are shown in Fig. 8. This bolster has a straight bottom and top member with no side bearing. The maximum stress in compression is 12,300 lb. with the exception of a point around the small hole at the end. The stress in the tension member is practically the same in both bolsters *B* and *C*.

The results obtained on bolster *E* are shown in Fig. 9. This bolster is the same as bolster *D* except that it has a side bearing cast on, the top of the bolster being continuous under the side bearing. The stress is practically the same as in the bolster without any side bearing, being a little greater just inside and outside of the side bearing where the change in section is rather abrupt.

The results obtained on bolster *F*, which was exactly the

same as bolster *E* except that the small holes at the ends had been moved in 3½ in. and holes cast in the top as shown in Fig. 10. It will be seen that the stresses around the small end holes were materially reduced, having a maxi-

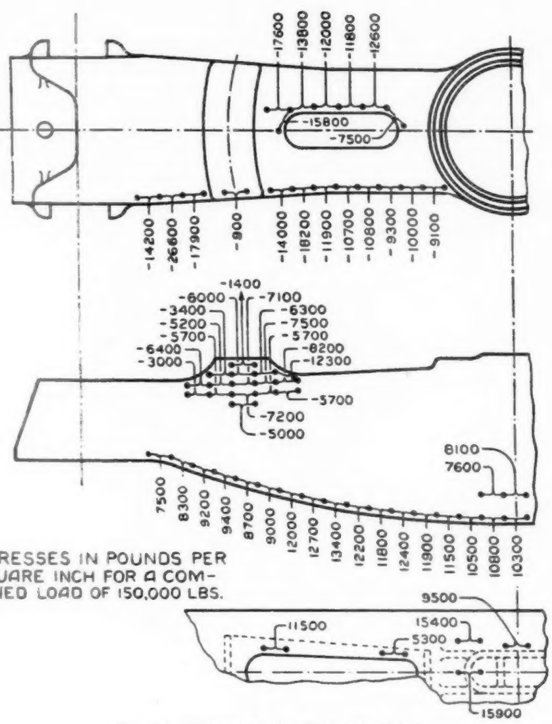


Fig. 4—Stresses in Bolster "A"

mum of 3,400 lb. The maximum stress in the compression member of this bolster was 13,700 lb. This was just outside and inside of the side bearing on top of the bolster. A stress of 13,400 lb. was obtained on the bottom of the com-

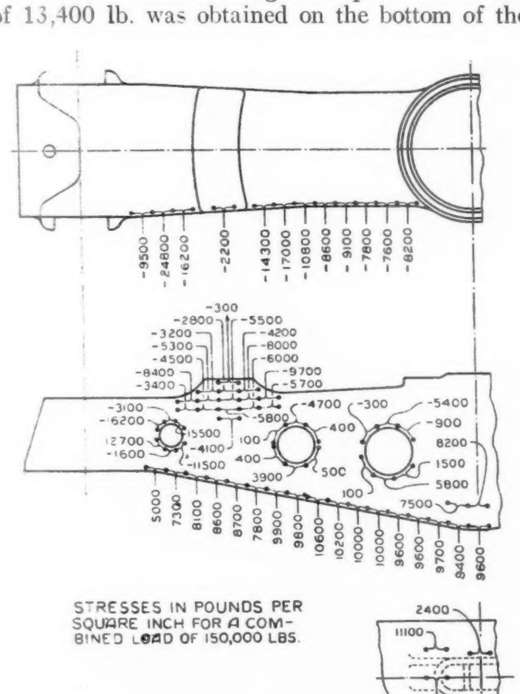


Fig. 5—Bolster "B"

pression member at the edge of the top hole, as is indicated in section *B-B*. The bottom of this bolster has a maximum stress of 10,700 lb. tension.

The design of bolster *G* and the results of its test are shown in Fig. 11. This bolster had holes in the sides and top, but none in the bottom. A stress of 20,500 lb. compression was developed in the top member at a point on the edge of the bolster about 18 in. from the end, and a stress of 15,900 lb. was developed in the tension member almost directly under the point. These high stresses are due to the small depth of the bolster, which has an effective depth of only 3⅝ in. as compared with 7 in. for those previously

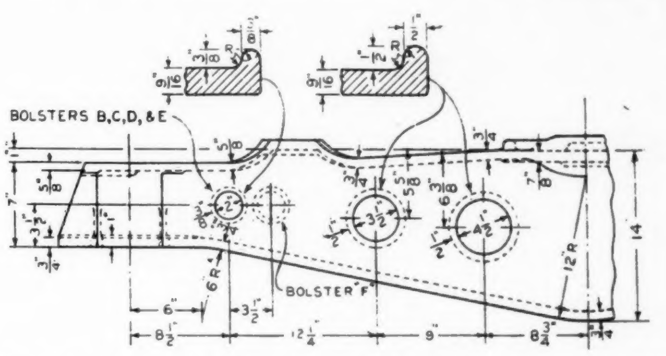


Fig. 6—Location of Holes in Sides of Bolsters "B," "C," "D," "E," and "F"

referred to. It will be seen that the stress is very small all along the tension member for a considerable distance out from the center. This bolster is 14¼ in. wide, while the others were only 11 in. wide.

The results obtained on bolster *H* and the details of the design are shown in Figs. 12 and 13. The results given in Fig. 12 are for a combined loading of 150,000 lb. It will

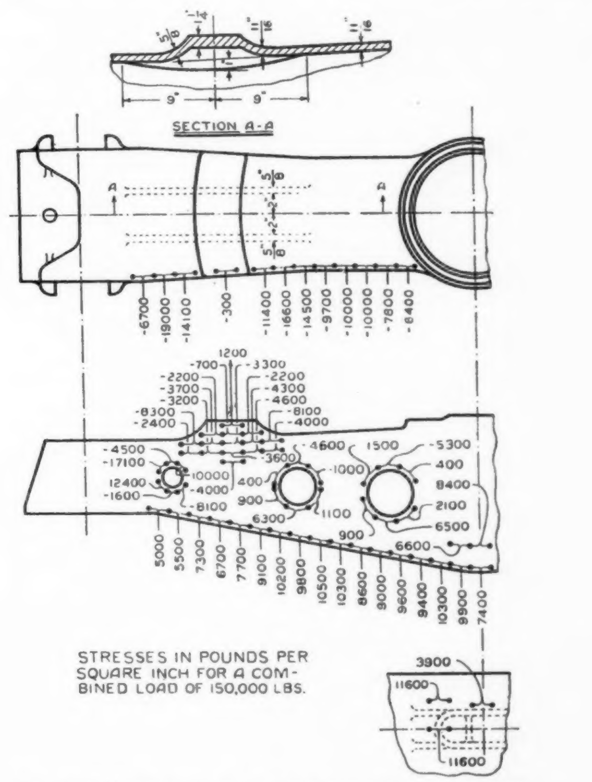


Fig. 7—Bolster "C" with Reinforced Side Bearings

be seen that the maximum compression point is at the outer end of the hole in the top of the bolster, where the stress is 19,600 lb. and that the stress is practically 19,000 lb. at the edge of the bolster along the side bearings. The tension stress is 23,000 lb. at a point just under the side bearings at the curve of the tension member. The tension stress is also high on both sides of this point.

Fig 14 gives the results obtained on bolster *H* under a

central load of 68,500 lb., and shows some interesting results. More readings were taken under this method of load-

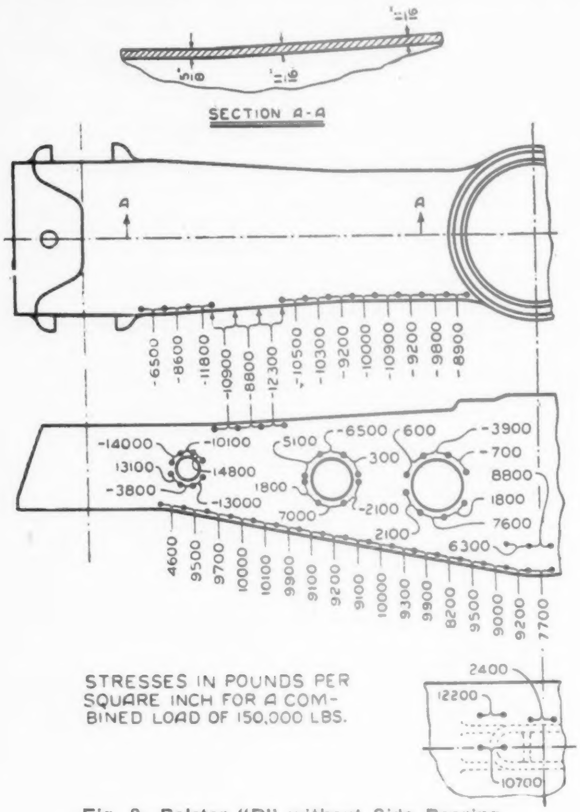


Fig. 8—Bolster "D" without Side Bearing

ing, including some on the inside of the bolster which are indicated as *B* readings. The half-section *A-A* shows the

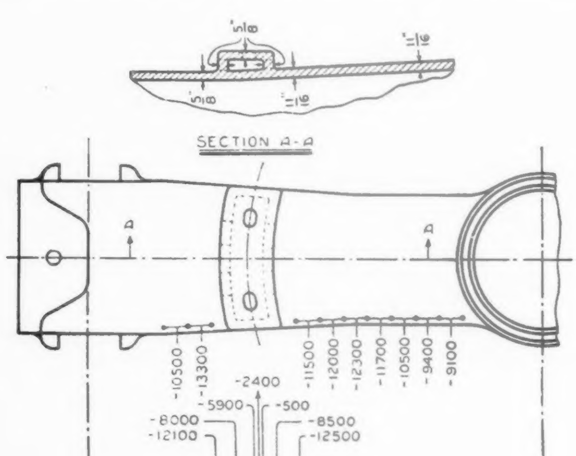


Fig. 9—Bolster "E"

difference in readings at the outside and inside of the bolster at the edge of the holes. Another point where the inside and outside stresses are different is across the inner

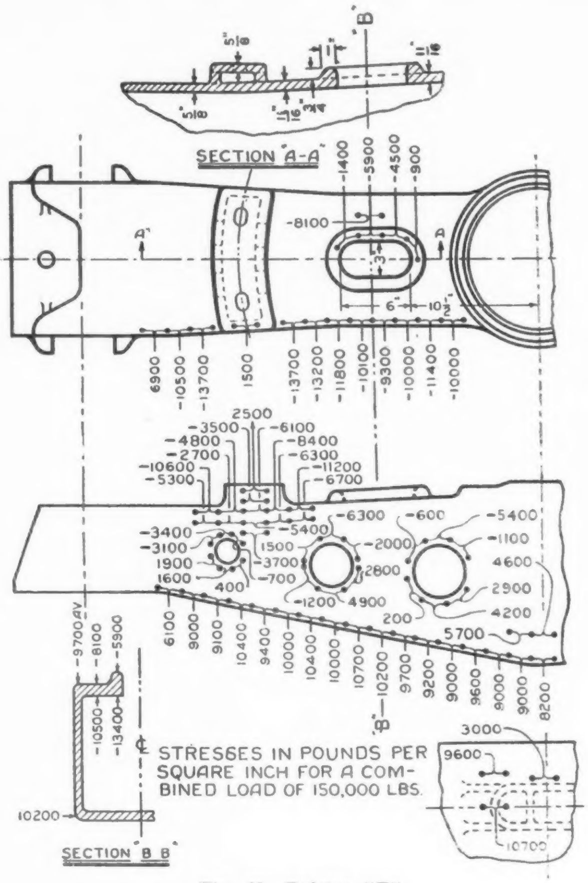


Fig. 10—Bolster "F"

edge of the hole in the tension member, where a compression of 16,200 lb. is shown on the outside and the *B* reading on the inside is 6,200 lb. tension, showing a strong ten-

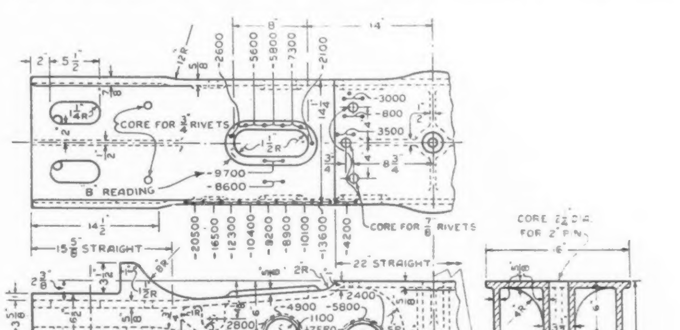


Fig. 11—Bolster "G"

dency to bend up at this point. The same thing is true at the outer end of this opening, where the stress on the outside is 11,300 lb. compression and on the inside 3,000 lb.

tension. Just the opposite tendency is true, but not to so great an extent, at the ends of the hole in the compression member.

The results obtained on bolster *I* are given in Fig. 13. This bolster was only tested under a central load of 68,500 lb. The interesting thing about this test is the results obtained from readings taken on top of the side bearings. These are plotted at the left of the drawing and show that the top of the side bearing is in tension 3,000 lb. at the center, gradually reducing until compression is shown at the outside edge. This tension is due to the side bearing bending up. The stress on the side of the bolster plotted at the left of section *2-2* shows that the compression in the side of the bolster at the corner is a little less than 10,000 lb.

Referring to the plot of the stresses in the top it will be seen that the lines in the two diagrams meet at a little less than 10,000 lb. Another interesting thing about this bolster is the effect of the hole upon the stresses, which are plotted at the right above section *1-1*. Here it will be seen

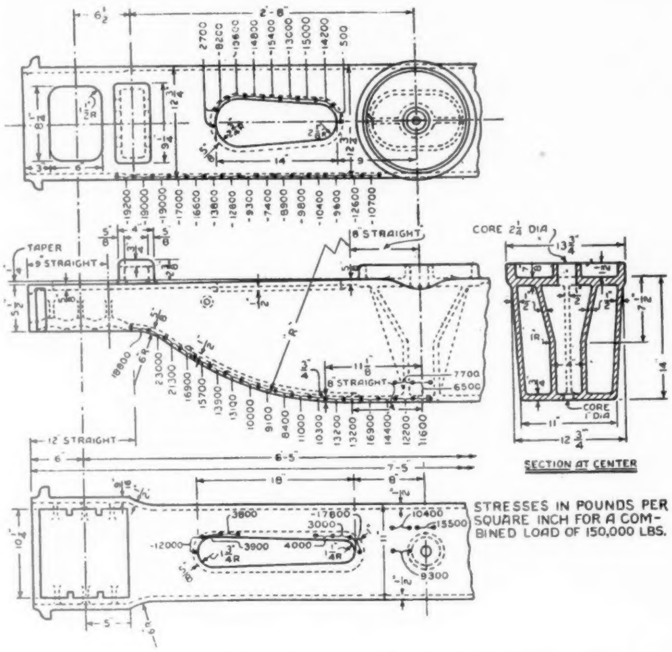


Fig. 12—Bolster "H" Under 150,000 Lb. Combined Load

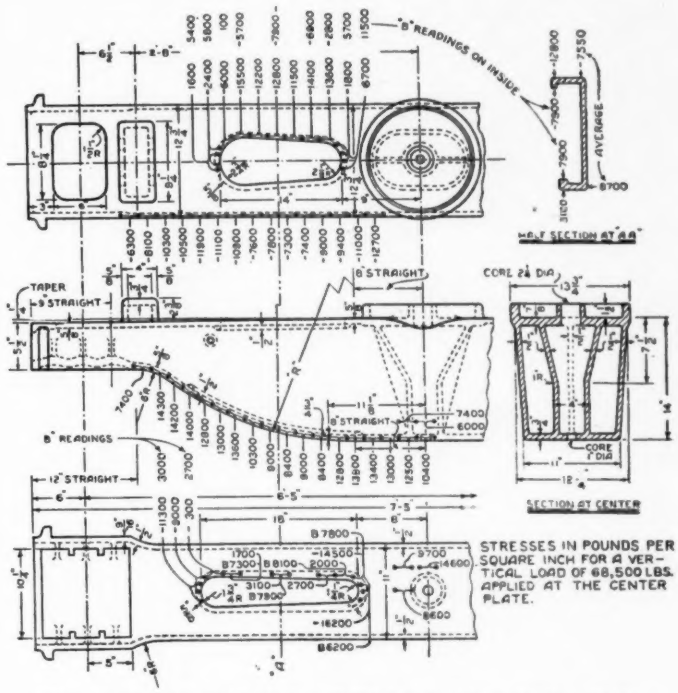


Fig. 14—Bolster "H" Under 68,500 Lb. Load at Center Plate

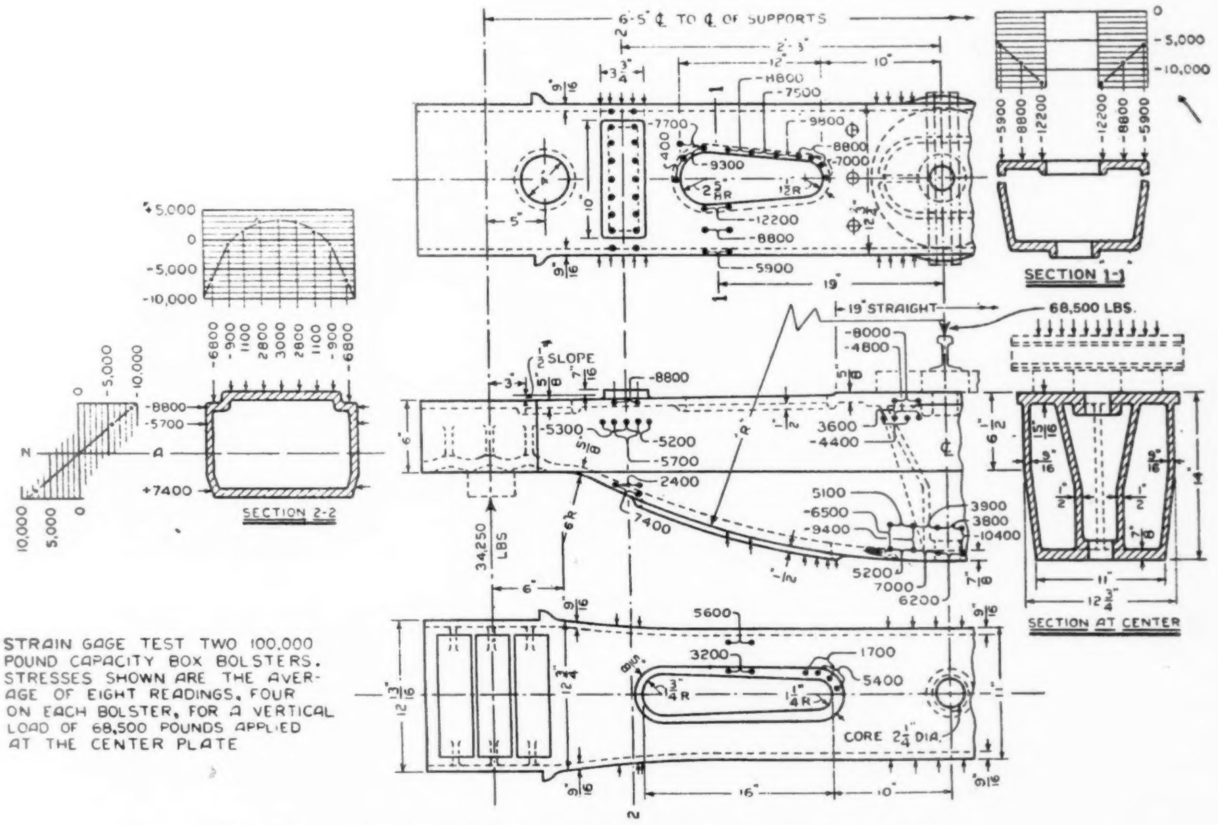


Fig. 13—Bolster "I" Under a 68,500 Lb. Load at the Center Plate

that the stress gradually increases at the outside edge from 5,000 lb. to a maximum of 13,000 lb. at the inner edge of the hole. In other words, this hole, because of its breadth, has a weakening effect upon the bolster. This, however, may be influenced some by the raised side bearing.

When testing a new design of bolster or side frame, I have white-washed a great many with a mixture of silica powder and water and this has helped a great deal in quickly locating weaknesses in design. While it is not an absolute check upon the Berry strain gage, it has given some very interesting facts.

Fig. 15 is a side view of bolster *E* that has been strained under a central load of 390,000 lb. There are no cracks around the side bearing on this bolster, the only cracks shown being above and below the two central holes. The end hole shows clearly, however, some shear cracks in the whitewash out from the center on the side wall. Of course this load is way above any load the bolster would ever attain, which is the reason for this scaling. This is a quick method for determining the points of maximum stress. It should not be assumed, however, that the stresses in this bolster previously referred to should check with the scaling photograph, as the latter was obtained under a central load

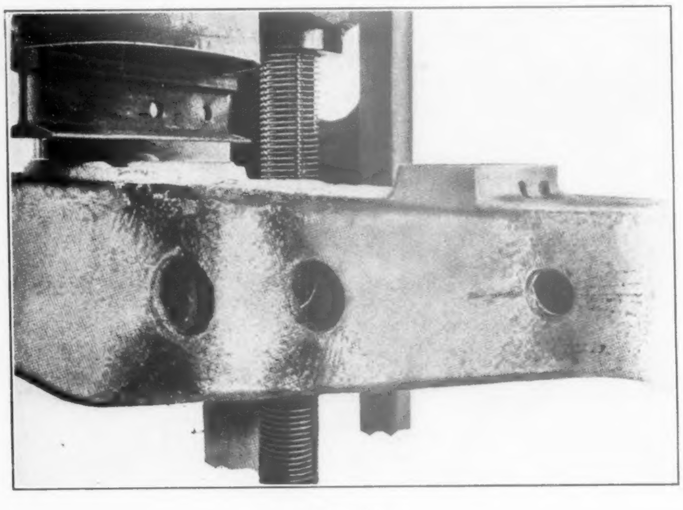


Fig. 15

only, while the results with the Berry strain gage were obtained under a load applied at three points.

CONCLUSIONS

There are a great many things to be considered in the design of a box bolster and some of the most important I have attempted to show in these tests. For instance, the depth at the end is an important thing and some designers of cars have not left sufficient space for this part of the bolster in laying out the car. This depth should be at least six in. Another thing which causes high stresses in some bolsters is the fact that cast steel can be made to almost any shape. The side bearings are cast on the bolster; that is, the top member of the bolster is not a straight, continuous web but is made up of several curved portions. This makes sharp corners on some bolsters and curved members on others. This is always a source of high stress. It is evident to every one that if a column—and that is really what the top of the bolster is—is made crooked, it will not be as strong as a column that is made straight. This also is true of the tension member. For maximum efficiency it should be made straight. While it often appears stronger from a comparison of the section moduli, in every case the tested straight tension member has a less maximum stress than one with a curved bottom, where the bolsters are otherwise comparable.

This brings up the question: Of what value is the old method of figuring the strength of any bolster? As long as you do not have curved tension or compression members and abrupt sections, the results obtained in a calculation of the bolster will check rather closely with the actual stress at any point. If the sections are not straight and uniform, the calculated stresses cannot be depended upon. I have found the calculated stress in some cases to be only 50 per cent of the actual stress and in other cases the calculated stress will be higher than the actual stress.

REPAIRING FOREIGN LOCOMOTIVES

"THIS is the railroad shop man's opportunity to do his bit," said the superintendent of one of the shops that has been repairing a large number of foreign engines. "It not only helps the country and the road that sends its locomotives to our shop, but it helps us as well. I have had a chance to observe the practices of these other roads and to see the results they give in service. I have got some valuable pointers, and will apply what I have learned to improve our own motive power." The attitude expressed in these remarks is typical of the position taken by the men in the shops that have been called on to assume the burden of repairing engines from other roads with facilities already congested by the home equipment. This is the spirit of men who recognize that the roads are now a unit—the servants of the government—the third branch of the service which is quite as essential in winning the war as the army and the navy.

From Chicago as far west as Topeka and Parsons, Kansas, and Ogden, Utah, and as far north as Brainerd, Minn., shops will be found working on locomotives owned by roads in the eastern section where the greater part of the war industries are located and where the unprecedented traffic has worn out engines faster than the shops could repair them.

The repairing of locomotives in shops of foreign lines was put into practice when the roads were taken over by the government. The regional directors secured information concerning the possible increases in the production of shops which were not working to full capacity, and early in the year the first locomotives were distributed among shops in the Middle West.

Careful preparations were made for furnishing everything that would be required in working on locomotives from foreign lines. Complete sets of blue prints and details of standard practices were sent with each engine. All parts were carefully inspected before the locomotives were shipped, and if this inspection disclosed that material would be required which the repairing road was not apt to have in stock, it was sent to the shop, either in the tender or in a separate car accompanying the locomotive. That the precautions were effective in facilitating the work is indicated by the comment of a foreman who remarked that he found little difference between working on foreign engines and on those of his own road.

When the locomotives were shipped they were usually given a thorough inspection by an inspector from the owning road, who accompanied the engine to the shop, and by the foreman of the road doing the work. At this inspection it was definitely decided what repairs were to be made, and if it was found that any additional material would have to be secured from the owner by ordering it at once the progress of the work as a rule was not delayed.

It is usually necessary to furnish a considerable number of small parts, such as grease cups, plugs and bushings, cylinder cocks, etc. Such material should always be sent finished, except in cases where each part must be fitted individually. These parts are usually produced in quantities, and each road has special facilities for making its own standard equipment. Where rough castings are sent to the road which is to repair

the locomotive, a great deal of time is wasted in finishing the parts.

In spite of all that could be done, it has been found that the most serious hindrance to the work was caused by delays in securing material. For instance, one locomotive in a foreign shop was found to have the tires out of gage. When the tire was heated in order that it might be reset, the wheel center was found to be cracked beyond repair. The defect could not be detected until the tire was loosened and several weeks elapsed before a new casting could be secured.

Next to the difficulty of obtaining material, the most serious embarrassment was caused by the variation in standards on different roads. There is a lack of uniformity in the amount of taper used on fitted bolts. If a hole is reamed with a reamer having either greater or less taper than that originally used, the diameter must be increased considerably to secure a bearing for the full length on long bolts. To avoid enlarging the holes unduly, it was necessary in some cases to send with the locomotive a set of reamers having the proper taper. The situation with regard to boiler screw threads was quite similar. Some roads used the V-thread and others the United States standard thread, and the amount of taper varies considerably.

The instructions issued by the owning road specifying the work to be done and the standard practices to be followed, were helpful in many cases, but in some instances they resulted in work being done which was quite unnecessary. Often the instructions called for the renewal of parts which had not been inspected before the locomotive was shipped, and in some cases it was found that the wear on these parts was so slight that they would have remained in service until the next shopping with minor repairs. Such conditions could be avoided by giving more authority to the inspector representing the owning company. These men who were chosen to oversee the work have had wide experience, and their judgment should be relied on. Furthermore, the foremen of the shops repairing locomotives from foreign lines are too jealous of their good name to allow a locomotive to go from the shop to another road in any but the best of condition. To place unnecessary restrictions on the methods of overhauling power indicates a lack of appreciation of the service which the roads taking in locomotives from foreign lines are rendering.

LARGE APPROPRIATIONS FOR SHOPS

The Railroad Administration Allows Liberal Expenditures for Improving Railway Mechanical Facilities

THE expenditures for improvements to railway facilities approved by the Railroad Administration through the Division of Capital Expenditures and made public on May 18, involve an amount chargeable to capital account of $937,961,318, of which $440,071,013 is for additions and betterments, $479,686,531 for equipment and $18,203,774 is for extensions. A detail study of the budgets of fifty of the more important lines, having an aggregate mileage of 151,494, shows that a particularly generous amount has been granted for improving the mechanical facilities and equipment. A summary of the expenditures granted these roads chargeable to both capital and operating accounts for these items is given in the table. About $65,000,000 has been approved for shop buildings, engine houses, etc.; for shop machinery and tools $9,248,249 has been appropriated and for improvements to existing equipment $33,132,313 has been granted. The amounts for shop buildings, etc., include expenditures to be made for additions to existing buildings, new shops and enginehouses, and the shop machinery and tools required for these new shops. It will thus be seen that considerable more than that shown under the heading of shop machinery and tools will be spent for these items.

It has been the disposition of the Railroad Administration in the consideration of the budgets, to grant those expenditures which will materially increase the capacity of the railroads. It has been known for a long time that the mechanical facilities for handling cars and locomotives have been deficient and for that reason particularly liberal amounts have been granted for this purpose. Fuel stations, water stations, etc., are other items which have been given particular attention, about $10,000,000 being appropriated for this purpose on the fifty roads shown in the table. Approvals for projects which might be considered unessential to winning the war have been made to cover, particularly on work that has already been started, amounts necessary to permit a cessation of the work without loss to the company. The following is a summary of the important work to be done on various railroads in improving the facilities for repairing and handling cars and locomotives.

IMPORTANT MECHANICAL FACILITIES AUTHORIZED

A large expenditure is to be made on the Baltimore and Ohio for shop buildings, enginehouses, etc. The largest single item in this account is the shop and enginehouse at Glenwood, Pa., just outside of Pittsburgh. This shop will have a capacity of 40 to 50 locomotives per month. Over $1,300,000 has been appropriated for the shop and enginehouse at Cumberland, Md., and a new shop and enginehouse will be built at Youngstown, Ohio, at a cost of $740,000; an extension will be built to the shop and enginehouse at Washington, Ind., for $272,730; an enginehouse will be built at Grafton, W. Va., at a cost of $328,086, and the shop and enginehouse at Dayton, Ohio, will be rebuilt at a cost of $225,000.

A particularly large amount, $3,407,221, has been given the Boston & Maine for shop buildings, enginehouses, etc. This includes an enginehouse at Concord, N. H., costing $800,000; one at East Deerfield, Mass., costing $770,000; one at Lowell, Mass., costing $750,000; one at Dover, N. H., costing $275,000, and one at East Cambridge, Mass., costing $143,500.

The Chicago, Burlington & Quincy will build an engine terminal costing $155,000 at Eola, Ill.

The Chicago, Milwaukee & St. Paul was allowed an expenditure of $680,000 for the engine terminal at Savanna, Ill.; $601,870 for an engine terminal at Ottumwa Junction, Iowa, and $236,000 for a freight and engine terminal at Atkins.

The Rock Island was granted nearly $1,000,000 for shop buildings, enginehouses, etc., which includes improvements at Herington, Kan.; Amarillo, Tex., Manly, Iowa, and Burr Oak, Ill. Over $1,000,000 will be spent for second track on this road.

The Cleveland, Cincinnati, Chicago & St. Louis has received $710,419 for shop buildings which includes engine terminals at Galion, Ohio; Sheff, Ind., and additions at various points.

A large amount has been given the Erie for shop buildings, enginehouses, etc.,—$2,382,156. This expenditure includes a 31-stall enginehouse and engine terminal facilities

at Meadville, Pa., at an estimated cost of $411,191. New engine terminals will be built at Girard, Ohio, for $400,000, and at Avoca, East Buffalo and Dayton, N. Y. A scrap reclaiming plant will be built at Meadville at a cost of $95,000.

The Grand Trunk has an appropriation of $1,058,609 for shop buildings, enginehouses, etc., which includes a 15-stall roundhouse at Pontiac, Mich., and improvements at West Bethel, Me.; Battle Creek, Mich., and Fort Gratiot.

The mechanical facilities of the Hocking Valley at various points throughout the system will be improved, $409,296 being appropriated for this purpose.

The Illinois Central was given $2,345,170 for shop buildings, enginehouses, etc., which will be used to improve the mechanical facilities at Kankakee, Ill.; Clinton, Ill.; Mattoon, Ill.; Freeport, Ill.; Waterloo, Iowa; Jackson, Tenn.; McComb, Miss.; Champaign, Ill.; DuQuoin, Ill.; Benton, Ill.; Carbondale, Ill.; Mounds, Ill.; Amboy, Ill.; Fulton, Ky.; Paducah, Ky., and Central City, Ill.

The Lake Erie & Western has been given over $800,000 for shop buildings and enginehouses, of which $500,000 will be for a locomotive repair shop at Tipton, Ind.; $158,200 for rebuilding the enginehouse at Lima, Ohio, and $79,200 for rebuilding the enginehouse at Peru, Ind.

The largest item of expense in the budget of the Lehigh Valley is for $2,514,114 to be spent for shop buildings, enginehouses, etc. A new engine terminal is to be built at Hazleton, Pa., at an estimated cost of $1,000,000 and a new engine terminal will be built at Jersey City at a total cost of $1,400,000, of which $900,000 has been appropriated for 1918.

The Michigan Central will make an expenditure of $2,231,080 for shop buildings, enginehouses, etc., which includes new engine terminals at Jackson, Mich., and Michigan City, Ind. Additional shop facilities will be provided at a cost of $335,000, and a new steel car repair shop will be built at West Detroit at a cost of $210,000.

One of the largest individual items for the New York Central is $7,707,600 for shop buildings, enginehouses, etc. This includes a car repair shop at Avis, Pa., for $746,000; new engine terminal facilities at Watertown, N. Y., for $700,000; a new enginehouse at Syracuse, N. Y., for $540,000; additions to the car repair shops at East Buffalo for $520,000; an addition to the erecting shop at Collinwood, Ohio, for $345,000; a new enginehouse at Genesee, N. Y., for $200,000; a car repair shop at New Durham, N. J., for $198,000; a new enginehouse at DeWitt, N. Y., and additions to the enginehouses at Norwood, N. Y.; Clearfield, Pa., and Cherry Tree, Pa.

The shops and enginehouses on the New Haven will be improved generally for handling heavy power, particularly the Santa Fe type locomotives which that road has received. Fifteen stalls will be added to the enginehouse at East Hartford, 10 stalls to the Medway enginehouse on the New London division and seven stalls to the Waterbury (Conn.) enginehouse.

The Norfolk & Western will spend $879,000 for the Roanoke (Va.) yards; $590,000 for the Hagerstown (Md.) yards and $565,000 for improvements in the Bristol (Va.) yards. In addition to this an additional new shop building will be constructed at Roanoke at a cost of $575,000 and $222,634 has been appropriated for the shop building at Shenandoah, Va., which is under way.

The principal feature of the Northern Pacific budget is a new car and locomotive shop at Mandan, N. D., towards which $500,000 has been appropriated. A new car repair shop will be built in the Como yards near St. Paul at a cost of $250,000.

The expenditure of $4,609,108 for shop buildings, enginehouses, etc., on the Philadelphia & Reading will include new engine terminal facilities at Reading, Pa., costing $355,000; a new addition to the enginehouse at St. Clair, Pa., costing $92,000; a new extension to the shops at Reading, costing $255,000; a new engine terminal at Tamaqua, Pa., costing $200,000; new engine facilities at Chester, Pa., $140,000; new engine facilities at Coatesville, Pa., costing $440,000; a new enginehouse and machine shop at Rutherford, Pa., costing $145,000, and $157,172 for engine facilities at Reading, which are 49 per cent completed.

With about $700,000 for shops the St. Louis & San Francisco will improve mechanical facilities at a large number of its repair points.

The Union Pacific will spend over $6,000,000 on terminal improvements, divided as follows: Cheyenne, Wyo., $1,689,425; Council Bluffs, Iowa, $1,647,351; Junction City, Kans., $1,175,007; Green River, Wyo., $919,674; Omaha, Neb., $535,026; Sidney, Neb., $158,935; Grand Island, Neb., $43,100; North Platte, Neb., $25,200; Ellis, Kans., $9,000. At Cheyenne a machine shop will be built costing $1,276,500. At Council Bluffs $440,000 will be expended for a 40-stall enginehouse, $293,000 for a power house, $235,000 for a machine, boiler and blacksmith shop and $175,000 for a 600-ton coaling station. At Junction City a machine, boiler and smith shop will be built at a cost of $270,000, a 20-stall enginehouse at a cost of $240,000 and a 400-ton coaling station at a cost of $110,000. The improvements at Green River include a 28-stall enginehouse costing $280,000, a machine, boiler and smith shop costing $235,000, a car repair shop costing $85,000 and a storehouse costing $68,000. At Omaha, Neb., an extension to the machine shop will be built at a cost of $245,000. Over $800,000 will be spent for machine tools for the various shops in this program.

EXPENDITURES FOR ADDITIONS AND BETTERMENTS TO MECHANICAL FACILITIES

Road	Shop buildings, enginehouses, etc.	Shop machinery and tools	Improvements to existing equipment
Ala. Grt. So	4,000	4,000	....
Atch. Top. & Santa Fe*	712,365	468,973	....
A. C. L.	101,648	....	430,667
Balt. & Ohio	5,981,950	645,270	1,626,373
Bos. & Albany	47,900	....	....
Bos. & Maine	3,407,221	22,914	2,633,692
B. R. & P.	779,959	197,960	313,649
Central of Ga.	143,599	3,749	167,000
Central of N. J.	300,000	....	423,921
Chesa. & Ohio	780,513	368,050	1,255,539
Chic. & Alton	185,000	....	65,624
C. & E. I.	181,367	....	954,061
C. & N. W.	1,119,063	199,126	....
C. B. & Q.	331,671	....	550,878
C. M. & S. P.	1,969,370	448,200	1,230,184
C. R. I. & P.	945,627	354,266	1,810,475
C. N. O. & T. P.	30,000	6,500	....
C. C. C. & St. L.	710,419	70,750	996,838
Cumb. Valley	742	488	....
D. & H.	90,307	30,304	732,168
D. L. & W.	308,102	24,775	419,369
D. M. & N.	186,155	....	10,500
Erie	2,382,156	....	677,793
Grand Trunk	1,058,609	128,314	20,391
Great Nor.	539,000	....	432,531
G. C. & S. F.	109,923	17,106	6,855
G. H. & S. A.	....	5,110	66,305
Hocking Val.	490,296	106,756	351,522
Ill. Central	2,345,170	537,932	1,471,823
K. C. S.	17,420	97,347	1,217,447
K. C. S. Term.	....	41,130	4,300
L. E. & W.	800,500	20,200	73,840
Lehigh Val.	2,514,114	230,538	669,472
Long Island	92,449	57,753	137,252
Mahoning Coal	787,400	....	....
Mich. Central	2,231,080	192,098	443,035
M. St. P. & S. S. M.	110,650	33,675	186,770
N. C. & St. L.	357,363	56,000	151,067
N. Y. C.	7,707,600	651,800	6,235,237
N. Y. N. H. & H.	1,486,389	469,974	1,793,036
N. & W.	1,082,638	275,000	1,261,301
Nor. Pac.	950,000	120,000	1,116,170
Pa. West	7,464,754	459,960	1,187,102
Pa. East	3,780,466	1,250,000	....
Phila. & Read *	4,609,108	....	....
S. L. & S. F.	699,150	207,141	1,139,944
Southern*	182,696	45,000	....
Sou. Pac.	608,964	73,555	507,762
Union Pac. System	41,134	448,475	343,898
U. P. Term Improvements*	3,811,000	835,040	....
Y. & M. V.	175,471	43,020	16,513
Total	64,752,478	9,248,249	33,132,313

* Amounts for all items were not available.

THE FUEL ASSOCIATION CONVENTION

A Wartime Meeting Conducted Under the Auspices of the Federal Railroad and Fuel Administrations

THE tenth annual convention of the International Railway Fuel Association, which was held at Chicago, on Thursday and Friday, May 23 and 24, 1918, differed materially from all previous meetings of the association.

The arrangements for the convention were made under the direction of the Railroad and Fuel Administrations, and the meetings were notable for the absence of all technical discussion of specific questions of railroad fuel supply and economy. The entire time of the convention was devoted to a broad consideration of the nation's war time fuel problem. Practically every railroad company in the country designated representatives to attend the convention and there were also present a large number of coal operators and other representatives of the mining industry.

Several changes were made in the list of speakers as announced in the tentative program published last month. C. R. Gray, director of the Division of Transportation, United States Railroad Administration, was unable to be present, and R. H. Aishton, director Western Regional District, United States Railroad Administration, addressed the meeting in his stead. Sir George Bury, chairman of the Canadian Railway War Board, was also unable to attend but was represented by Thomas Britt, general fuel agent of the Canadian Pacific Railway. United States Fuel Administrator, H. A. Garfield, and Warren S. Stone, grand chief of the Brotherhood of Locomotive Engineers, also found it impossible to be present at the convention.

The convention was opened with an introductory address by the president of the association, E. W. Pratt, assistant superintendent motive power and machinery, Chicago and Northwestern. An abstract of Mr. Pratt's address follows:

PRESIDENT PRATT'S ADDRESS

There are three items in this tremendous fuel problem—production, transportation and consumption—and the railroads of this country are largely responsible for all three of them; for production in so far as concerns the delivery of machinery and supplies to the mines and a car supply for the coal produced.

The next item is transportation. Railroad men are a hardy and earnest lot and not easily discouraged, working every day in the year, including Sundays and holidays. But when last winter, after weeks of continued and unprecedented snow and cold, their locomotives were compelled to operate with added disadvantages of poor and dirty coal it was perhaps the greatest obstacle of all and many a locomotive died and its train was abandoned for this reason. I have yet to see a miner or operator who would defer to the railroad man in the matter of patriotism or loyalty to country, and I believe if the proposition is put squarely up to the men that there will be no Sundays or holidays in either the mine, on the railroad or in the coal yard when it concerns the output and distribution of coal, any more than there is Sunday or holiday in the trenches with the Hun facing our boys and the Kaiser menacing our free institutions.

The 27 per cent of the coal produced which is used by the railroads is so large that we hope by care and close attention to details not only as to firing but in better repair of locomotives, more care in despatching and moving trains, and better operation on the part of the engineer, to save millions of tons of coal and millions of gallons of fuel oil. Superheating has been proven practicable and each locomotive so equipped saves hundreds of tons of fuel per year besides rendering faster and better service; hence, the present practice of superheating the larger locomotives passing through the shop should be continued as far as possible, considering the scarcity of materials and skilled labor to apply them. The locomotive feed-water heater also offers an attractive field for economy and efficiency and well warrants careful and continued experimentation.

"The Railroad Industrial Army," was the subject of a paper by W. S. Carter, director of the division of labor of the Railroad Administration. An abstract of this paper, which dealt with the conditions demanding extraordinary

effort and increased productiveness from every railroad man, will be found on page 314 in this issue.

RELATION OF LOCOMOTIVE MAINTENANCE TO FUEL ECONOMY

BY FRANK McMANAMY
Manager Locomotive Section, United States Railroad Administration

Fuel economy and locomotive maintenance in practically everything that relates to efficient locomotive performance, are synonymous terms. Within recent years the increasing cost and scarcity of fuel have made fuel economy a question of major importance to the designor of locomotives as well as to the officials in charge of locomotive maintenance. The inventor has also turned his talents in that direction, with the result that the superheater, the brick arch, the combustion chamber firebox, and other fuel saving devices, are today parts of the equipment of every modern locomotive. The influence of these devices in effecting real fuel economy is tremendous, and their application to many existing locomotives will result in a marked reduction in fuel consumption.

The boiler, to promote economy of fuel, must be properly designed, with ample grate and heating surface. It must be clean, the grates level and easily shaken and in good condition, the ash pan and grates must have ample air openings to aid combustion, the firedoor should operate easily, and the fire tools should be in good condition. The flues must be clean, the flues and firebox free from leaks, smokebox must be air tight, the smoke stack and nozzle in line, and the draft appliances in good condition and properly adjusted.

Too much stress cannot be laid on the necessity for keeping boilers clean, because in addition to effecting a material saving in fuel, it increases the efficiency of the locomotive and materially prolongs the life of the flues and firebox sheets. Frequent and thorough boiler washing is the foundation of proper boiler maintenance. Authorities differ somewhat as to the exact loss due to scale on boiler sheets but a comparison of tests made indicate pretty conclusively that 1-16 in. of scale will increase the fuel cost approximately 15 per cent and that ¼ in. of scale will increase the fuel cost approximately 60 per cent.

It is not an exaggeration to say that on an average 40 per cent of the locomotive boilers in service have scale 1-16 in. thick or to say it differently, that due to poor boiler washing all of them have 1-16 in. scale 40 per cent of the time, and that many have scale from ⅛ in. to ¼ in. in thickness. In fact in some districts it is not unusual to find ½ in. of scale on boiler sheets. Let us see what this means in actual figures. In 1918 it is estimated that the railroads will require 166,000,000 tons of coal at an average cost of $3.50 per ton, which will be a total of $581,000,000. If we add to this 48,000,000 barrels of fuel oil it will make the total fuel cost over $650,000,000. We will pay, therefore, during the year of 1918 more than $50,000,000 for fuel on account of the scale in locomotive boilers that many men do not consider of sufficient importance to warrant its removal.

But even a boiler that is clean and in the best of condition can do no more than generate steam; proper steam distribution to and from the cylinders must be had and the steam made to do effective work. If the valves are out of square or blowing or the valve gear badly worn; if valve chambers or cylinders are badly worn or out of round; if the cylinder packing is worn or broken; if leaking piston rod packing or leaks about the steam chests or cylinders dissipate the steam that should and could be made to do work, we can expect no improvement in our fuel performance.

Assuming, however, that the boiler is in good condition, that the steam distribution is good, and that there is no waste of steam through steam leaks, it remains to deliver this power at the drawbar, and this cannot be efficiently or economically done through the medium of wornout machinery. Rods in bad condition, boxes loose on journals, wedges which require adjusting, and tires badly worn which will cause excessive slipping, are poor mediums through which to transmit energy.

Some of the repairs which will do the most towards reducing the fuel consumption and improving locomotive performance arranged in what is believed to be the relative order of their importance, are, setting the valves properly and maintaining the valve motion, washing the boilers, keeping the tubes clean, eliminating steam leaks about the cylinders and the steam chests and maintaining the driving boxes and rods.

If it were possible to calculate the aggregate loss in operating efficiency for the total number of locomotives due to lack of maintenance or operating at less than their maximum efficiency, the result would be staggering, and when we add to this enormous loss of operating efficiency, from 10 to 20 per cent of the railroad fuel bill which for the past year was $329,000,000, and for the current year is estimated to be $581,000,000 for bituminous coal alone, we begin to realize the price we have been paying for the privilege of operating defective locomotives and delaying traffic thereby. This being true, the question that must inevitably follow is, what is being done by the U. S. Railroad Administration to remedy the conditions which have been described.

The first step before taking action to bring about an improvement in the condition of locomotives was to make a survey of the field. The next step was to speed up locomotive repairs to provide motive power to meet the immediate needs and this was done by increasing the shop hours about 16 per cent for over 200,000 men, and by nationalizing locomotive repairs so that a locomotive in need of repairs would be sent to the nearest available repair shop, thus utilizing to the fullest extent the total shop capacity of all railroads. The result of this soon became apparent in the increased number of locomotives turned out of the various shops which for the four months ended April 30, increased 6,849 over the corresponding period for last year. This not only means more locomotives but it means better locomotives, which both increases operating efficiency and decreases fuel consumption.

For the future the work that has been started will be continued and a higher standard of condition of locomotives required. A regular schedule for the application of superheaters and other fuel saving appliances to locomotives not now equipped, is being prepared and will be adopted subject only to labor and material being available.

Today, with the increased demands for fuel by reason of the war and the necessity for furnishing fuel to our allies; with the increased use of fuel in industries whose output is essential to the successful conduct of the war, the saving of fuel by better locomotive maintenance and the increased operating efficiency which will result therefrom, means more than can be expressed in terms of tons, gallons or dollars. It means the saving of America, the saving of Democracy, the winning of the war.

THE MOTIVE POWER DEPARTMENT AND FUEL ECONOMY

BY ROBERT QUAYLE
General Superintendent Motive Power and Car Department, Chicago & North Western

In 1917 the railroads of this country consumed approximately 175,000,000 tons of coal. This, at an average price of $2.50 a ton, would give us a cost of $437,500,000. Now I maintain that if every individual in the operating end of the railway organization of this country were to work together as one man, each helping the other to the one end of

saving fuel, we could easily save 10 per cent, which would be 17,500,000 tons equivalent to $43,750,000.

I want, first, to call attention to the master mechanic's part in this game of saving fuel. He should be in touch with the division superintendent and train despatchers in such a way as to make them feel and really know that he is interested in them personally. It is the master mechanic's duty to be so in touch with his shop men and engineers and firemen that they will have confidence in him, and he should have the happy faculty of having the men constantly feel kindly toward him. This would enable him to get the best from the men that can be had.

He should fix the machines that the men are going to handle, so that the men will have the least amount of discouragement in their work, and there will be the least amount of effort on their part necessary to get the best results. To this end he should have his men trained to make proper reports of necessary work to be done. Occasional meetings with the roundhouse foremen, particularly calling attention to these things, and insisting upon their having the work done that is reported, will bring about good results. The engineers will take much more interest in making the detailed reports than if their reports are not given proper attention.

My next thought is the traveling engineer. What are his duties? To make inspection of locomotives; see that they are in proper condition to do the best work. He should know the condition of every engine in his charge. He should know what they are capable of doing. He should see to it, at the roundhouse end, that the engines leave fully capable of making the trip successfully and economically. He should always have it in mind that his job is one of helpfulness and instruction rather than one of fault finding and improper criticism.

The roundhouse foreman, as a rule, is the most abused man on a railway. He is up against all kinds of conditions, all kinds of problems to work out, in order that everything may move smoothly and every man be kept one at peace with the other. We require a good deal of the roundhouse foreman, and to get the very best out of his job he should be gracious, he must needs be a philosopher, he must be a student of human nature and he must smile even when everything goes "dead wrong."

Locomotive engineers and firemen, what a magnificent opportunity you men have to show your patriotism by your work! On the basis of your loyalty and faithfulness I am asking you to redouble your efforts; increase your intelligence not only for yourselves, but strongly urge every other fellow not only to do his bit, but to do his all, that fuel will be conserved. Fuel is now playing and will play a most important part in our warfare.

You will observe that what I have said can be summed up in a word, co-operation, and I am sure when we of the motive power department will have done our part that the men at the other end of the operating department will say to us, "You have done well." We all respond to success, and when the men in one department have shown a great improvement the other fellows will not only follow in the wake, but they will try to beat them out in the end if they can.

E. W. Pratt (C. & N. W.)
President

L. R. Pyle (M. St. P. & S. S. M.)
Vice-President

W. L. Robinson
Vice-President

J. G. Crawford (C. B. & Q.)
Secretary-Treasurer

TRAIN LINE LEAKS AND THE COAL PILE

In a paper enitled "The Transportation Department and Fuel Economy," E. H. De Groot, Jr., assistant manager, car service section, United States Railroad Administration, drew attention to the part that superintendents, train masters, yardmasters, despatchers, trainmen and the station forces should play in a general campaign of fuel economy. Referring particularly to the possibilities for effective work on the part of train men, Mr. De Groot said:

"The air compressor on the modern locomotive is a powerful engine. It performs wonders which are little enough appreciated by most of us but it has a frightful appetite for steam—and steam means coal. Its cylinders are large, and as its load increases directly with the progress of the piston, the steam cannot be used expansively but must be admitted to the very end of the stroke. Under these circumstances, air leaks constitute a direct drain upon the boiler and so reach their greedy fingers back through the firebox into the precious coal pile. There is no way in which the trainman can contribute so much toward the good cause of saving coal as by stopping the train-line leaks before starting on the trip. With porous hose, worn gaskets, pipe and other leaks, what the pump has to overcome needs no description among practical men.

"Leaks are crimes when coal is a military necessity! To stop leaks then is of the greatest importance and this should be done carefully and conscientiously. Surely, any man who does less than he can, does less than he ought in this. The practice of carrying a hose-gasket or two in the pocket as some trainmen do for this purpose is an excellent one. Rainy weather offers an opportunity to locate hose which are porous to a serious extent and by changing them when opportunity offers much fuel may be saved which would otherwise be wasted.

"But all of the leaks are not discoverable while the train

is at rest, particularly in cold weather, and new ones develop during the trip. These should all receive first-aid treatment as soon as found. Then, too, the leaks may result in sticking brakes and this condition is like compounding a felony. It not only takes much coal to pump against the leaks but much more coal at the same time to pull against the brakes."

THE RAILROADS AND THEIR RELATION TO THE FUEL PROBLEM

BY R. H. AISHTON
Regional Director, Western District, United States Railroad Administration

I was appointed Western regional director last January, just about the time that we were in the thick of the fuel problem. I never want to go through such an experience again; and neither do the railroad men. There were times when there was not four hours' fuel in this city. If, by any effort of mine, and any effort of yours, we can prevent that thing occurring again, let's do it. Unless we do it, the coming winter is going to be much worse than last winter.

Suppose that we get the same enthusiasm on this fuel question, the same patriotic impulse on the part of every man in the vast army of two million railroad men in this country, that was shown in the Liberty Loan drive. There would not be any fuel famine; there would be no difficulty. There would not be any railroad problem if we would just do that. If we save one scoop of coal an hour on each locomotive it will save 765,000 tons of coal, or 17,000 carloads a year. Does any man in this audience believe that he cannot do that?

There is scarcely a man on a railroad that does not have some relation to coal saving. Take the man in the shop. The intelligence put into the work and its inspection has an immediate effect on the amount of coal a locomotive burns. The car man can have an immediate effect on coal consumption in the care of journals and lubrication. The train despatcher, with a little more energy and forethought in ordering his trains over the road, can save just as much as the fireman. The agent at the country station may keep a train waiting two or three minutes. The enginemen have to burn coal generously to make up the time lost through the agent's carelessness.

All of us—railroad men, consumers and everyone who has anything to do with this movement—must get into the attitude expressed in Order No. 8 issued by Director General McAdoo on February 21.

SUGGESTIONS FOR SAVING COAL

BY THOMAS BRITT
General Fuel Agent, Canadian Pacific

To say that good engineering is an essential element in the process of conserving fuel is to mention a basic principle. Our locomotive and boiler-house firemen cannot be too well instructed on this point; with them, in the final analysis, rests the successful issue of our present campaign. Mechanical devices such as superheaters, automatic fire doors, etc., may accomplish a great deal in avoiding unnecessary wastage, but certainly the human element is the dominant factor—we cannot get away from it. Our firemen are as loyal as any group in the service, but quite frequently they fail to grasp the seriousness of the situation that confronts us, as well as the importance of the occupation which is theirs.

Another tangible means of saving coal to win the war is to substitute wherever possible, utilizing gas-house coke for heating stations, etc. A considerable amount of scrap wood can be utilized as fuel in shop boilers; old ties can be gathered up and burned for the same purpose.

I might more earnestly ask in exchange for our share in this worthy enterprise that our railroads be not overburdened any longer with a lot of foreign matter under the guise of coal. I have found it necessary to have whole carloads of this extraneous matter dumped into the ditch, it being absolutely worthless as fuel for any purpose. The situation is much worse if such matter finds its way into ships' bunkers—transports especially—for then the lives of thousands are placed in needless jeopardy.

The overloading of tenders has been the cause in the past of an incalculable waste. Thousands of tons have been lost by scattering coal along the highway. Measures have been taken to avoid this frightful deficit. Ashpits also are frequently a source of wastage.

Looking at the question in a broad way, is it not quite evident that we are just beginning to wake up to the necessity of economy? The pinch of want together with the soaring of prices are making us all realize that our only salvation lies in saving.

THE NEED FOR FUEL CONSERVATION

BY P. B. NOYES
Director, Bureau of Conservation, United States Fuel Administration

The coal supply is short. Last winter it was short and the immense new requirements for war purposes threaten to make it shorter still next winter. The data we have compiled show that 625,000,000 tons of bituminous coal will be needed this year. The mines which must get out the coal, and the railroads which must carry it, were pressed nearly to their limit before the war. They cannot take on 200,000,000 tons of additional production. Fix your minds on what you know of the burdened condition of the leading railways three years ago. Add to this the tremendous burden of war supplies, troop transportation, material for ship building, and food for our Allies, and then picture to yourself what it means to those same railways with facilities little if any greater than three years ago, to provide transportation for 200,000,000 additional tons of coal. Conceive of this increase as 16 solid trains of gondola cars filling 16 tracks from New York to San Francisco. A veritable freight yard filled with coal cars extending the breadth of this continent. And this represents only the *increase* of coal transportation demanded of the railroads. All of those four million cars must be switched in and out and carried hundreds of miles by our already burdened transportation system if war demands are to be met and the usual industrial life of the country be at all preserved.

The coal business is in physical proportions so far beyond any other business in the country that emergency remedies which can be successfully applied to any of the others will hardly make a dent in the coal shortage. To meet the demands this year 12,500,000 tons of bituminous coal must be hauled every week. And yet, the success of the war is likely to depend just on this supply of coal. As much coal as was mined last year will be needed this year for war purposes alone. We must save 65 or 70 million tons or go to the restriction of so-called non-essential industries.

There has been much talk of shutting down non-essential industries but a little investigation shows that only a short distance down this road lies financial ruin and unemployment of labor on a scale which would bring disaster at home and failure in war. At least twenty billion dollars of capital is invested in legitimate manufacturing enterprises producing goods not strictly needed for the war. Ten million men support their families from the work they do in these factories. Granted that we must have 100 per cent fuel for munitions and ships, we shall fail as a nation if we do not provide this without a complete breakdown of our whole industrial system.

Fuel is a small part of the raw material of most manufacturing institutions. The fuel expense in most highly organized industries is little over one per cent of the total cost of the goods. On the other hand, this one per cent is absolutely

vital. Without it the factory closes. The other 99 per cent are useless. We are called upon to view a ton of coal as equal to five or six hundred pounds of ship plates or shells, but every ton of coal saved for our factories means the employment or non-employment of a hundred men.

This is the new idea I wish to bring you today. That over and beyond the desperate need of coal for war purposes lies an equally desperate need of coal to preserve the lives and happiness of the population. The threatened shortage of coal can easily mean unemployment and financial ruin. If you remember that railway locomotives burn more than a quarter of all the coal mined in the country, you will not accuse me of exaggeration when I say that it is in your power and in the power of the railway fireman and the organization with which he works to save enough coal to turn threatened national disaster into national prosperity.

I am especially interested today in getting through to you the full significance in this crisis of every man's "doing his best." Few men ever reach 100 per cent of their possible efficiency. Most of us never reach 50 per cent. Any man who through enthusiasm or other stimulus, gets up to 75 per cent of his possible, is a brilliant success in his field of endeavor. The background of this terrible war is raising the efficiency of every man and woman in the United States. The more the meaning of the war has come home to us, the more we have approached our possible efficiency. This is a real force and should be applied directly to the problem of fuel economy.

There has been much discussion as to what will "win the war." Not every one, I fear, has faced the terrible alternative of what it would mean to lose the war. Let me tell you what I think it would mean.

Only once in civilized times has a single race dominated the world. Only once has a swollen tyranny proved so powerful that no human power could oppose it. The Roman Empire was such a world dominion—brutal, resistless. The Roman Empire could not be destroyed from without—it died from internal decay. But what did this mean to the world? The Roman Empire was one thousand years decaying. A thousand years known in history as the "dark ages." For a thousand years civilization and all that it stands for went backward into darkness.

Here is the black threat of the present struggle as I see it. Another brutal autocracy threatens to slip the leash and get beyond the power of civilization's curb. Another world dominion, another Roman Empire. And it is not of the tyranny, the slavery and misery of that world empire in its heyday that I am thinking. It is of the ages of decay. For a thousand years, perhaps five thousand, the world would struggle in darkness while the German Empire was decaying. In my mind, we are not struggling for the happiness of our children or grandchildren. It is for 50 generations which, if we fail to win this war, may flounder in the black mire of a powerful but decaying German Empire.

It is with such a background that I appeal to you to make the efficiency of your work 100 per cent perfect.

THE FUEL OIL SITUATION

A paper on the fuel oil situation was prepared by M. L. ReQua. In his absence the paper was read by Robert Collett, assistant manager of the Pierce Oil Corporation. An abstract of the paper follows.

The normal increased consumption of fuel oil for the year 1918, based upon the average increase over a period of 14 years, will approximate something over 20,000,000 bbls. An abnormal increase, due to war conditions, will probably greatly add to this amount.

A large percentage of the tank steamers which have hitherto supplied the Atlantic coast refiners with their supply of crude oil from Mexican and Gulf ports have been taken over by the navy for trans-Atlantic service. As a consequence a material readjustment in transportation facilities becomes necessary. Arrangements have been made by which crude oil deliveries by pipe line to the Atlantic coast will be increased about 26,000 bbls. per day—which is equivalent to about 20,000 bbls. per day of fuel oil. Still further increases in pipe-line capacities are under way which will materially increase their efficiency. But at the very least calculation an additional rail movement in tank cars of about 100,000 bbls. per day will be necessary in order to take care of the urgent fuel oil requirements in the Atlantic coast territory.

It will be necessary to move a great many trainloads of fuel oil for the shipping board and the navy from Texas or Oklahoma to the various ports on the Atlantic coast, and the supply of tank-car equipment will be taxed to its utmost. Any saving in this movement, by substituting coal for oil in the territory east of the Mississippi and permitting the fuel oil so saved to move by the shorter distances from the Indiana-Illinois fields and from the Pennsylvania fields to the Atlantic coast, will represent a very great saving in transportation.

Another feature of our problem is to convince the consumers of petroleum products of the necessity of increasing their storage capacity and to take advantage of the summer months to accumulate storage to carry them over during those months when the transportation facilities will be congested. This applies equally to the railroad companies and those industries that have been in the habit of living from hand to mouth, as it were, in the matter of their oil supplies.

A campaign of education for the prompt unloading of tank cars by the railroad shops is very urgent. Motive power departments particularly have a habit of partly unloading a tank car at one shop, then switching it to another division point for further unloading. In this way they are responsible for the outrageous abuse of tank cars of private ownership.

INDIVIDUAL EFFORT TOWARD FUEL SAVING

BY EUGENE McAULIFFE

Manager, Fuel Conservation Section, Division of Transportation, United States Railroad Administration

The most important angle of my subject to which consideration should be given, is that of individual effort, greater effort, a more unified effort than we have in the past attempted. We are making tremendous strides toward greater individual effort. We have passed the first mile post; but what we who remain at home, we, the real reserve force of the American army must do, is to complete the work of reconstruction of our daily lives so as to make ourselves a living, breathing, fighting part of the country's military force, standing unalterably behind the men who have gone to the front.

War is a contest, not alone of fighting skill, but of mining skill in tons output; of railroad skill as measured by raw and finished materials moved; passengers, including soldiers and sailors, moved. There can be no middle course, we must take on more responsibility. More work. One-third of the man power of the country, or more than ten million men are now directly or indirectly engaged in the war and the end is yet far off. At this time I can only urge effort, studied effort, along the lines you men of experience well know; with the maximum of patience in dealing with the thousands of new men who are entering the mines and the transportation service. A little more effort, a trifle better understanding of the supreme necessity of completing the task we have begun, looking to the present hour as one of cheerful sacrifice, the future one of return, in spiritual and material wealth.

OTHER BUSINESS

The part which the mining industry should play in the solution of the fuel problem was discussed in two papers,

one presented by Harry N. Taylor, vice-president of the Central Coal & Coke Company, Kansas City, Mo., entitled "What the Coal Operator Can Do"; and the other by John P. White, labor adviser of the United States Fuel Administration, on "What the Coal Miner Can Do to Help." The meeting on Friday was also addressed by C. E. Allen, deputy fuel administrator of Illinois, who spoke on "The Supply and Distribution of Fuel."

On Thursday evening motion pictures prepared under the direction of Major E. C. Schmidt of the United States Railroad Administration on the Minneapolis, St. Paul & Sault Ste. Marie were exhibited. These films showed the results of good and poor methods of firing by scenes on the road and close-ups of the interior of fireboxes. The proper methods of building fires were also illustrated and sections of the films pointed out the need of co-operation by employees in all departments of the railroad in order to secure the maximum economy in the use of fuel. Several copies of these films will be sent out by the United States Railroad Administration and it is the intention to have them exhibited before audiences of railroad men through all sections of the country.

On Friday afternoon a business session was held at which the following officers were elected: President, L. R. Pyle, fuel supervisor M., St. P. & S. Ste. M.; vice-presidents, C. M. Butler, supervisor of fuel, Atlantic Coast Line; J. B. Hurley, road foreman of engines, Wabash Railroad, and H. B. MacFarland, engineer of tests, Atchison, Topeka & Santa Fe; secretary-treasurer, J. G. Crawford, fuel engineer, Chicago, Burlington & Quincy. Executive committee for two years: R. R. Hibben, assistant fuel agent, M. K. & T.; B. P. Phillippe, coal agent, P. R. R.; T. Duff Smith, fuel agent, Grand Trunk Pacific; A. N. Willsie, chairman fuel committee, C., B. & Q.; for one year: H. B. Brown, superintendent fuel department, L. V.; L. J. Joffray, general fuel inspector, I. C.; H. Woods, fuel inspector, C. & A.

During the meetings addresses were made by Sergeant Brown, a Canadian soldier; Trooper Scott, of the Anzacs, and Private Peat. A detachment of the band from the Great Lakes Naval Training Station furnished music for the convention.

CAR WHEEL DROP PIT

BY J. V. HENRY

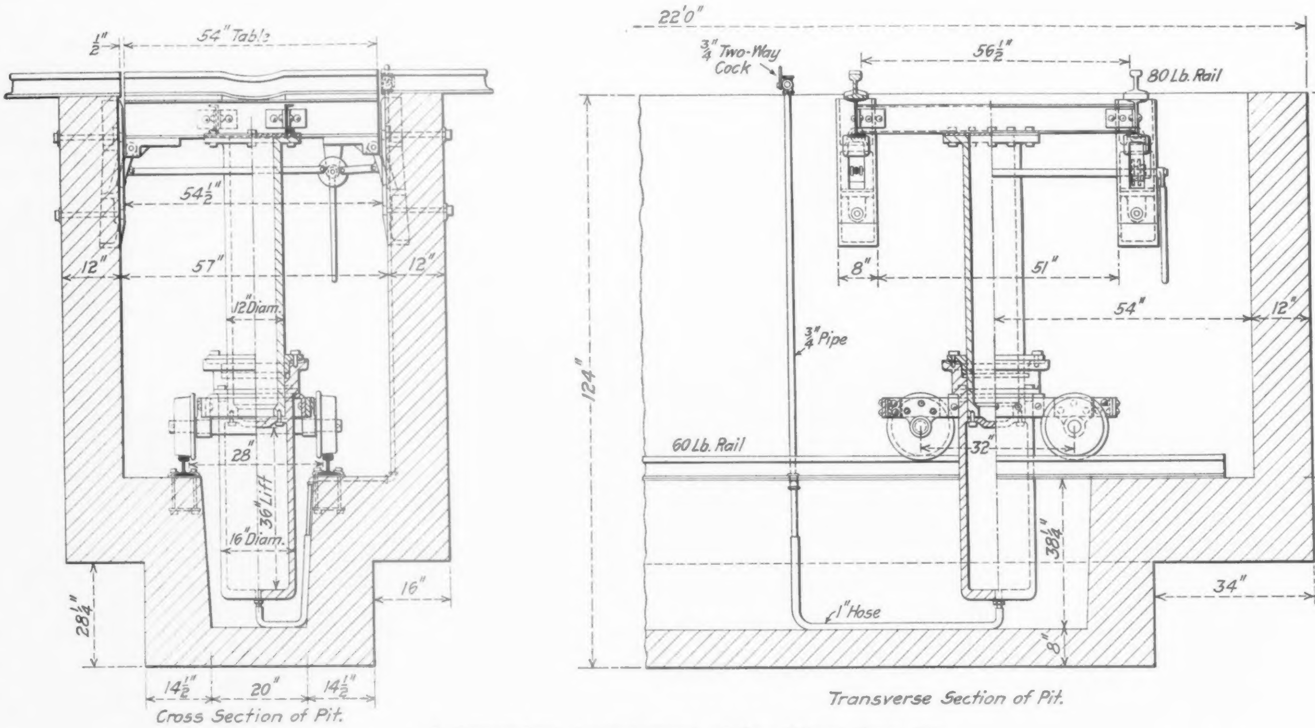
The design of a drop pit for car wheels shown in the illustration will interest those in charge of shops where cars must be jacked up when wheels and axles are required to be removed for replacement, tire turning or journal trueing. Roads owning their own foundries can make the necessary castings at a nominal expense and, due to present market conditions, even those roads who purchase their castings will find it economical to make their own patterns and purchase the rough castings. If it is not convenient to locate the drop pit in the shop, a suitable location should be found on a track that is not used very much, building a short siding if necessary.

The table consists of two 8-inch I-beams, supporting the track rail, which has a 1-in. depression at the center to prevent the wheels from rolling off the ends while being lowered and raised. Two 6-in. channels, which are fastened to the I-beams, also connect to a 12-inch ram, which operates in the cylinder. An air-tight joint is maintained between the cylinder and ram by a split cast iron gland and leather packing. The cylinder is bolted to a four-wheel built up truck operating on 60-lb. rails secured to the foundation by ⅝-in. anchor bolts.

The table, when not in use, is supported by a latch arrangement consisting of a latch plate set in the foundation, and a bearing bolted to the 8-in. I-beams, in which the latch works. The latch is operated by means of an operating cam and levers, the table being raised slightly to disengage the latch from the plate when it is desired to lower the table.

The arrangement shows the table operated by means of air from a ¾-in. pipe leading through a two-way cock to a 1-in. hose, which is of suitable length to allow the table to make its full transverse travel. If desired, hydraulic pressure can be used to operate the table. For a pit of this depth, a drain will be required to allow the water to run off.

The value of this drop pit is due to the considerable saving in the time and labor required to jack up a car, remove the truck, jack it up and change the defective wheels.



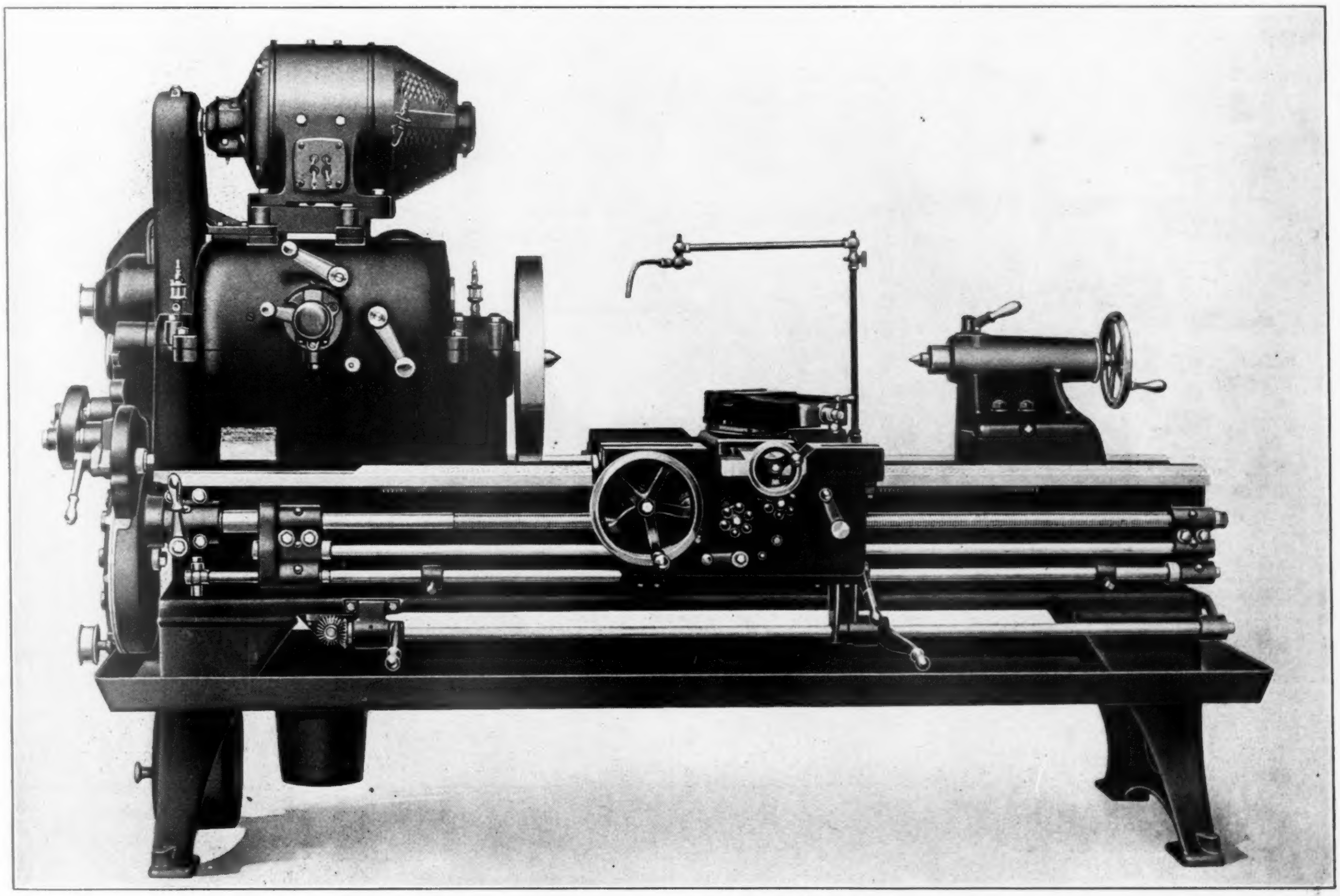
A Convenient Arrangement of Car Wheel Drop Pit

NEW DEVICES

MOTOR DRIVEN GEARED HEAD LATHE

A motor driven geared-head lathe of high power, built by the Springfield Machine Tool Company, Springfield, Ohio, is shown in the illustration. It has several features which make it well adapted to railway machine shop use. The lathe is simple in construction and operation and is of heavy design, having a particularly large range of speeds. All gears run in oil and with the selective type head there is no running of unnecessary gears. The lathe may be arranged for belt or motor drive. All journals in this lathe, excepting the main spindle journals are ball-bearing and a ball thrust bearing is also provided. Twelve speeds in geometrical progression are obtained by means of 14 gears. The power is transmitted from the belt to the spindle with the least number of gears possible. Any speed may be directly obtained and it is not necessary to pass through any series of speeds in order to reach the one best adapted to the work being done.

The entire head mechanism is enclosed in an oil-tight case, all gears running in a bath of oil and all bearings having stream lubrication. The main spindle journals are supplied with sight feed oilers in order to show that the proper amount of lubrication is being obtained.



General View of 18-In. Motor Driven Geared Head Lathe

The clutch pulley is on the rear of the head and contains a friction clutch operated by a push rod, which allows the lathe to be started and stopped instantly. The head may be furnished with a reversible drive if desired.

The construction of the lathe in general is compact, permitting all shafts to be short and of large diameter, which reduces chatter and vibration, and permits smooth finishing cuts. All operating levers are in front of the head and readily accessible which insures easy operation and maximum production. The lathe can be furnished in four sizes,

14 in., 16 in., 18 in. and 20 in. The dimensions of the 18 in. lathe are as follows:

Swing over bed	19 in.
Swing over carriage	13 in.
Distance between centers for 6-ft. bed	1 ft. 6 in.
Front bearings	3¾ in. by 7 in.
Rear bearing	2¾ in. by 5¼ in.
Hole in spindle	1 9/16 in.
Diameter of spindle nose	2¾ in.
Threads on spindle nose	4 threads Acme
Number of spindle speeds	12
Diameter of head pulley	14 in.
R.p.m. of head pulley	325
Spindle speed range with the above	9 to 380
Speed of countershaft	325
Size of C. F. friction pulley	14 in. by 4¼ in.
Motor drive horsepower recommended	3-5
Speed of motor	1,200

BULLARD 61-IN. MAXI-MILL

The most recent development of the Bullard Machine Tool Company, Bridgeport, Conn., in vertical boring and turning mill construction is embodied in its 61-in. Maxi-

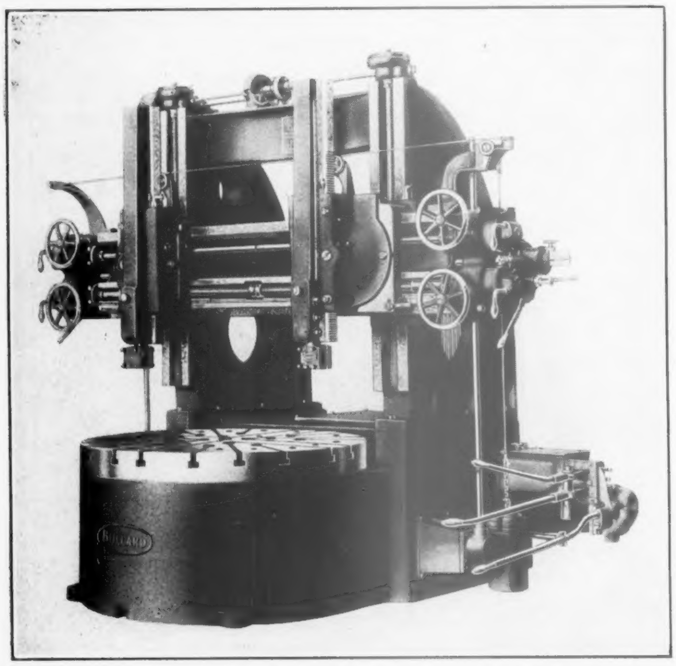


Fig. 1—Bullard 61-In. Maxi-Mill

Mill. A general view of this machine is shown in Fig. 1. Although the general design of the machine is new, most of

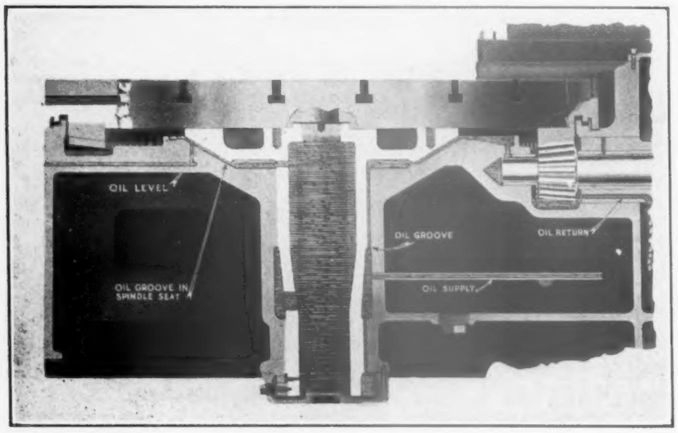


Fig. 3—Table Spindle and Oiling Arrangement

the units, such as the drive arrangement, feed mechanism, spindle construction and lubrication system have been adapted from tools of previous design where they have demonstrated their value. The special features of this machine are its power, rigidity, ability to take heavy cuts and the elimination of waste time in its operation.

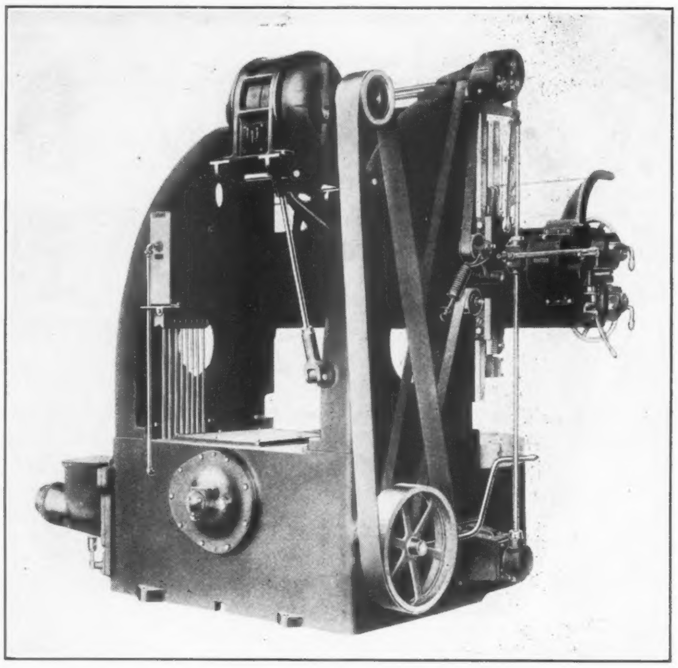


Fig. 2—Rear View Showing Oiling System and Motor Drive

The steel gears and shafts throughout are made of heat treated chrome nickel steel. The continuous flow system of lubrication of all gears, bearings and spindles with an in-

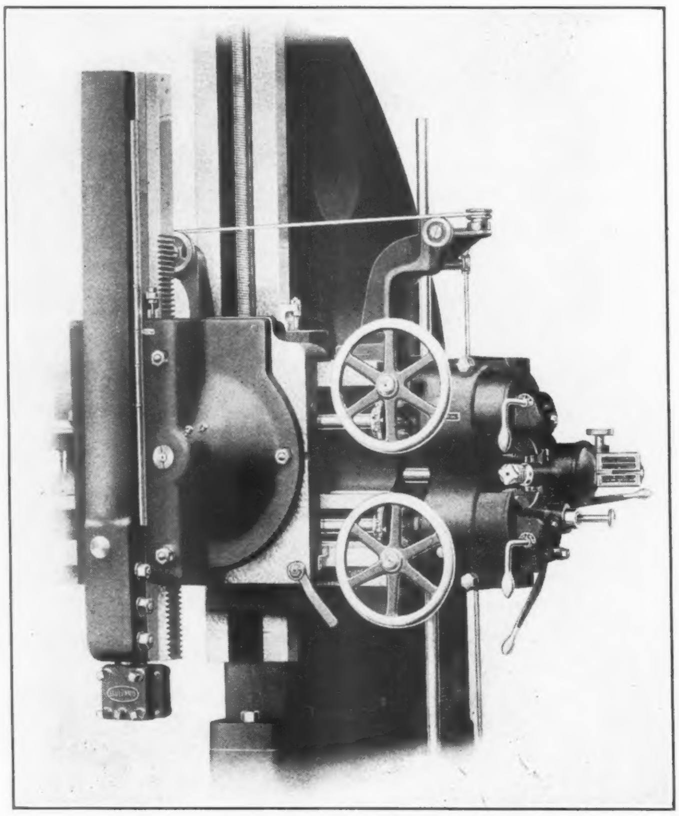


Fig. 4—Right Hand Head Showing Feed Mechanism

tegral filter insures cleanliness of the oil and freedom from delays due to scored bearings and overheated boxes. Fig. 2 shows the oiling system and also the motor drive arrange-

ment, the left-hand clutch and brake lever, the power traverse head and the left-hand feed work.

The method of oiling the table is illustrated in Fig. 3. Oil is maintained at a constant level and a continuous stream fills the reservoir. In overflowing the oil lubricates the table gear and pinion as well as the bearings.

The control is centralized, and the convenient arrangement of control handles, which is indicated in Fig. 1, adds to the productiveness of the machine. The control clutch and brake for starting and stopping the table is within easy

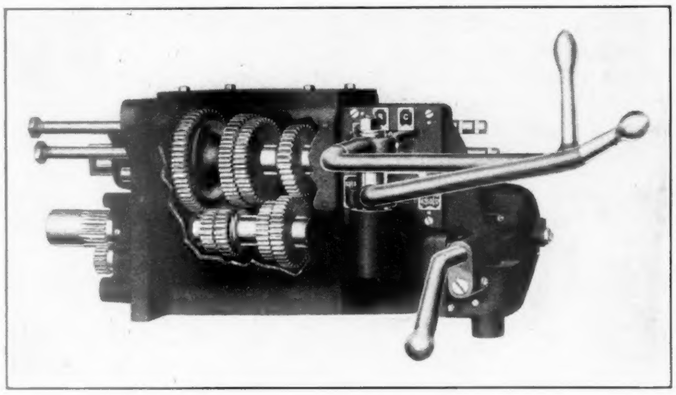


Fig. 5—Primary Speed Change Case

reach whether the operator be on the right or left hand side of the machine.

The ability to use large amounts of cutting lubricant without the possibility of its entrance into the machine itself, is an item of considerable importance which has been kept in mind in the design of every detail and is the result of a series of experiments extending over a period of four years.

Crank handles on shafts revolved at high speeds to obtain rapid traverse of the head are dangerous and have been eliminated. Patented hammer handwheels, shown in Fig. 4, which put lost motion to good use and eliminate all danger, actually increase the operator's ability to obtain fine settings of the tools. The clearly graduated scale mounted on the tool slide gives the coarser settings and micrometer dials,

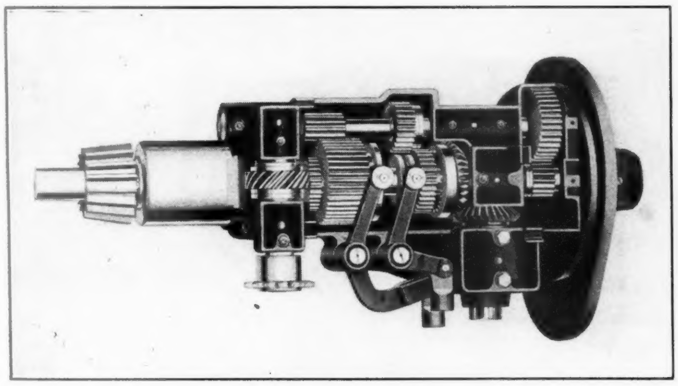


Fig. 6—Secondary Speed Change Case

giving graduations to thousandths of an inch, give the finer readings. The same arrangement of graduated scale is used on the face of the cross-rail.

The primary speed change case is shown in Fig. 5, and the control levers and interlocking system, together with the gearing arrangement are plainly indicated. Fig. 6 shows the secondary speed change case which is built for maximum power and durability.

The 61-in. Maxi-Mill is adapted to machine work up to 61 in. in diameter, 52 in. high under the cross-rail and 52 in. under the toolholders. The table is provided with parallel T-slots for the use of four face-plate jaws. There are 12 table speed changes ranging from 2.5 to 42.18 r.p.m. made by sliding gears and positive friction clutches. These are operated by conveniently located levers which interlock with the clutch and brake lever. Eight feed changes range from 1-96 in. to ½ in. per revolution of the table, either vertically or horizontally.

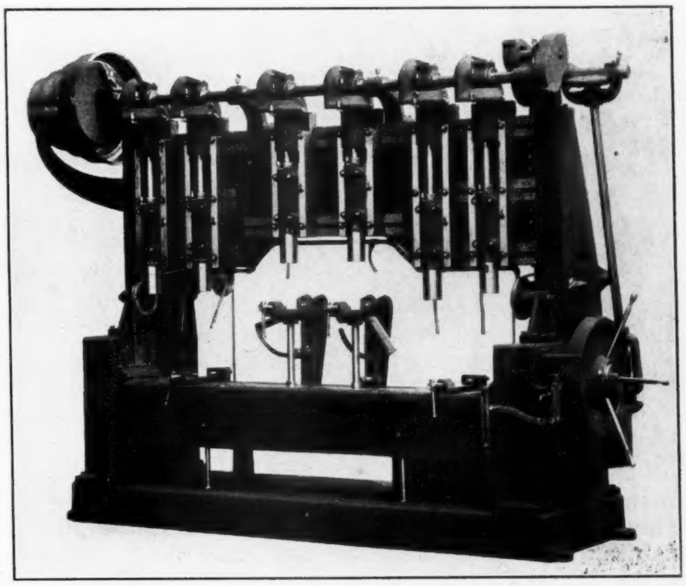
The tool slides are of special high tensile cast iron in the box form, with inserted tool holders. A vertical movement of 36 in. is obtained by means of a steel rack and pinion and the tool slide may be swiveled 45 deg. either way. All gears and shafts are made of heat treated, oil tempered, alloy steel, except the table drive gear which is of such design and dimensions as to preclude heat treatment. The hardness of all gears is 70 as measured by the sclerescope. All gears are encased, but are readily accessible and the table is guarded.

The bearings and gears with a fixed relation to the bed are lubricated by a continuous flow system by which filtered oil is circulated through a pump directly connected to the main drive shaft. This pump operates at all times when the main driving wheel is in motion.

The 24-in. driving pulley has a 5½-in. face and should run at 405 r.p.m. The best source of power is a constant speed motor of 15 hp. The weight of the machine is 28,000 lb. net and the floor space required with motor drive is 11 ft. by 13 ft. The height of the machine with the bars in the extreme upper position is 130 in.

ARCH BAR DRILLING MACHINE

The six-spindle arch bar drilling machine illustrated, which is made by the Foot-Burt Company, Cleveland, Ohio, is especially adapted to the heavy duty drilling of modern truck arch bars. For the sake of greater rigidity the heads of the machine which carry the spindles are bolted securely to the main cross-rail and are adjustable for the taking of different sizes of arch bars. The table is of the heavy box



Foot-Burt Six Spindle Arch Bar Drilling Machine.

section type, well ribbed, and is fed up to the spindles by means of heavy racks and pinions. The pitch line of these racks and pinions is directly under the center of the spindles.

The ways of the table are also directly in line with the center of the spindles, thereby eliminating all overhang to the table and allowing it to feed up directly against the center of the spindles. The uprights are of heavy box sec-

tion type, as well as the cross-rail, which is strongly ribbed to withstand unusual strain.

The spindles are carried in bearings which are bronze bushed, and these bearings are adjustable vertically 5 in. to take care of the different lengths of drills. All spindles are fitted with ball thrust bearings. The driving bevel gears for the spindles are made of steel forgings with hardened planed teeth.

The machine is now arranged with four changes of feeds by means of transposing gears on the end. The clamping mechanism for holding all the different sizes of arch bars, required to be drilled will be found convenient to operate and efficient. The machine is furnished complete with oil pump, piping and tank, the machine table being arranged with a large oil groove extending entirely around the outside. A suitable supply of cooling compound is thus provided for which makes it possible to force the drills to the limit of their capacity.

The Foot-Burt Company is prepared to furnish this arch bar drill with eight spindles, the two center heads of the machine in that case being arranged with the spindles set at fixed centers, but adjustable between each pair of fixed center spindles to handle arch bars when designed with eight holes.

Locomotive Prices in England.—The Taff Vale Railway of England has recently given orders for some new locomotives which, the chairman of the railway company says, will cost £7,000 ($35,000) each instead of the pre-war price of £2,300 ($11,500) each.

A HEAVY 42-INCH PLANER

The 42-in. planer shown in Fig. 1 is manufactured by the Bickett Machine & Manufacturing Company, and is built from new patterns throughout. This design is heavy and is adapted for both heavy and light work.

The bed of the planer, shown to the best advantage in Fig. 1, is of the solid, box type, especially heavy where gearings and housings are mounted, the bearings for the bull wheel shaft being $8\frac{1}{2}$ in. long. Heavy box girths at short intervals securely tie the walls together. The V's are wide and well proportioned, so that there is no possibility of the table tilting, even in making heavy cuts at the extreme edge of the table.

The oiling system has had special consideration. Besides being fitted with the usual automatic oil rollers, all pockets

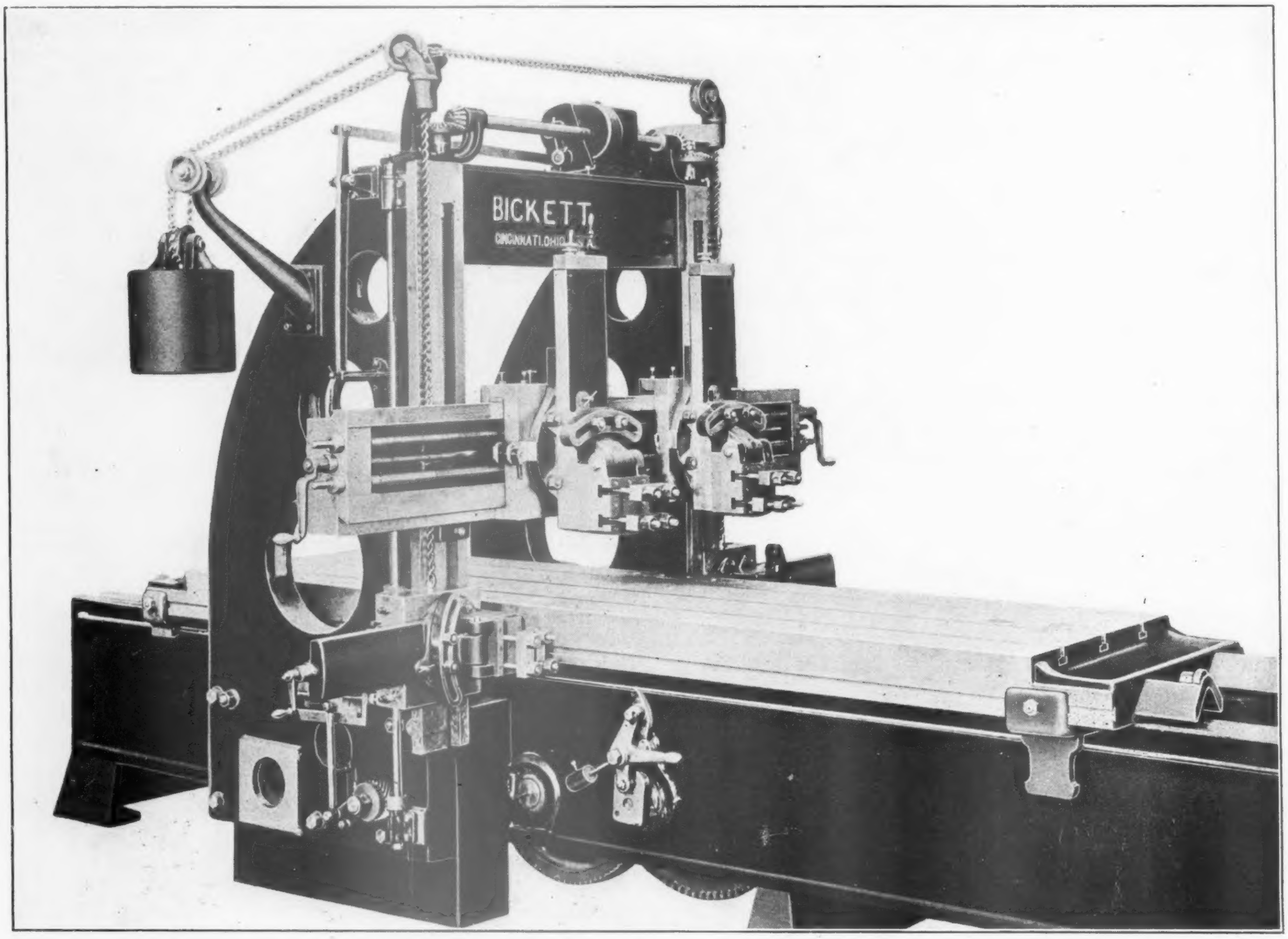


Fig. 1—A 42-In. Bickett Planer Designed for Heavy Work

are connected by pipes, making lubrication uniform throughout the entire length of table and bed and reducing the possibility of abrasion or cutting.

The table is of substantial construction, with heavy ribs at short intervals to guard against any possibility of springing. The "T" slots run the full length and are planed from the solid metal. Stop holes are drilled and reamed throughout the table, and countersunk to prevent chipping. Suitable dirt guards prevent any dirt getting in the V's. Each section of the rack is secured to the table by dowel pins, in addition to heavy cap screws.

The housings are of the box type, with heavy ledges resting on the cheeks of the bed, which support the entire weight of the housing and top arch. One-inch by one-inch steel

keys between the cheeks of the bed and the housings prevent them from moving or getting out of line. Housings are securely bolted to the bed with tapered bolts and dowel pins and fastened together at the top by a heavy boxed arch, which assures absolute rigidity when the cross rail is at the highest point.

The faces are accurately scraped, trued to surface plates, and carefully aligned, to be sure that they are parallel and perfectly square on the bed. Taper bolts are used throughout for greater accuracy and rigidity.

The full width of the machine can be used by one head, the cross rail being of such length that the other head can be run to the extreme end, to avoid interference with the working head.

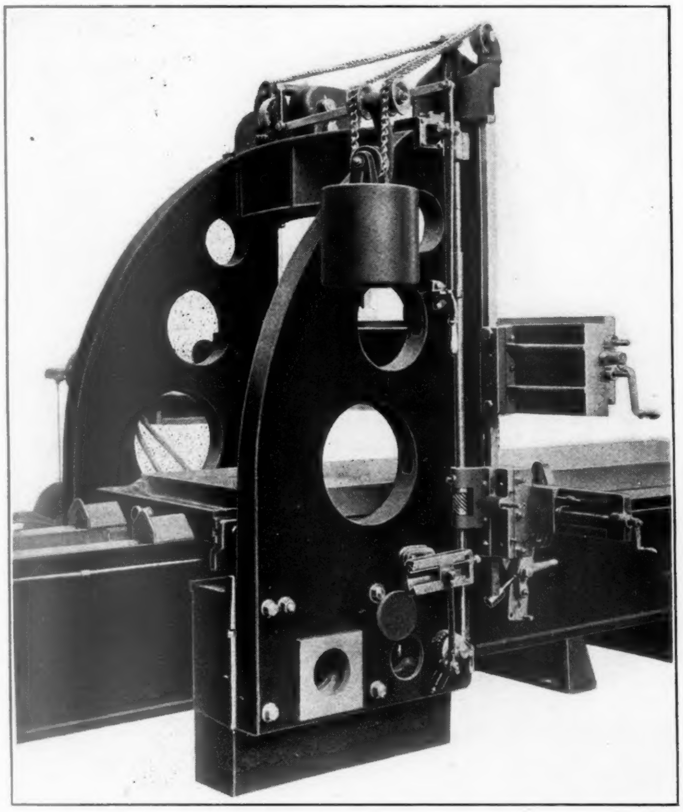


Fig. 2—Large Housings Are Rigidly Connected

The cross rail is of great depth and has a deep curved back. The distribution of metal is such as to resist the torsion of heavy cuts, eliminate the possibility of chatter, and make accurate and well finished work. Bearing surfaces are accurately scraped to straight edges and surface plates, and the back is scraped to the bearings on the face of the housing. Tightening screws are provided for securely clamping the slide to the swing and the saddle to the rail without disturbing the normal adjustment of the gib. Right and left hand saddles are used, making it possible to work the heads close together. Thrust ball bearings on both rail screws and the rail rod mean long life and ease of operation.

The rail heads are made of extra heavy design, fitted with a wedge gib having only one regulating stud at the top end, which makes the tool solid at any position or angle. The tool bolts are made with a large thread, assuring rigid clamping of the tool in the tool holder, which has hardened serrated tool plates.

The clapper boxes are of a heavy design and accurately made. The vertical feed range on the 42-in. planer is 15 in., and all heads are equipped with micrometers reading in thousandths of an inch. Heads are graduated at 45 deg. each side of zero, giving wide range in adjusting the tool. The cross feed and down feed screws and rods are provided with adjustable ball bearings, taking thrust both ways, thus increasing their efficiency and making the operation much easier.

The planers can be equipped with one or two side heads, as desired, or they may be attached at any time after the purchase of the machine. They are provided with independent power and hand vertical feed, and can be run below the top of the table when not in use. Counterbalance weights and chains for the side heads are furnished with them.

Side heads are independent of each other and of the cross rail heads, and can be used separately, or in conjunction with the cross rail heads as desired.

The screws which control the feeds are furnished with micrometer readings in thousandths of an inch, and the handles are always convenient to the hand of the operator. The adjustment of the vertical feed screw nut avoids any possible chance of back lash in the feed screw.

The control mechanism is on the outside of the machine and is readily accessible for all adjustments and oiling. A safety link on the control lever makes it impossible for the operator to lose control of the machine, and a safety lock holds the planer while work is being set up.

The elevating gear box located on top of the arch is driven by a separate belt, and has gears of wide faces and large pitch, that are always in mesh. Shift is made by a positive clutch, the shaft and pulley being the only parts revolving when not in use. The automatic positive feed has an oscillating yoke controlled by movements of the cam plate of the belt shifter. The feed rack for the cross rail is accurately cut from bar steel, and meshes with steel pinions of heavy pitch. The ratchet pinion on the rail rod and screw have knurled caps for feed changes, which are very convenient and quick in action. All feeds can be changed from fine to coarse without stopping the planer, and may be stopped and reversed instantly.

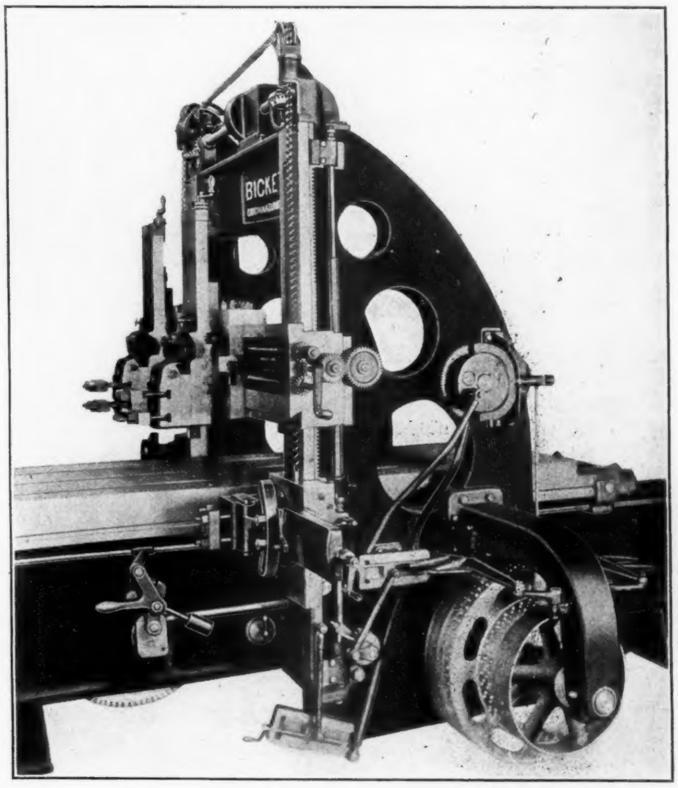
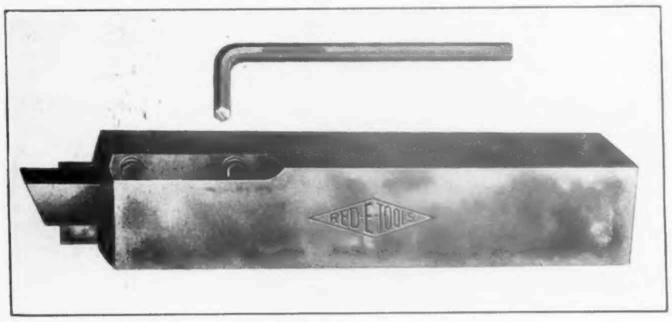


Fig. 3—Arrangement of Driving Pulleys and Operating Levers

Perforated aluminum pulleys allow the escapement of air and causes the belts to adhere, thereby eliminating the noise and slipping due to the rapid shifting of belts when running at high speed. Wide-faced driving gears are mounted on extra heavy shafting within the bed, and the bearing bushings are ample to eliminate all possibility of cutting, undue heating or any friction of moving parts. All gears are covered with a one-piece gear guard, thus insuring the safety of the operator.

READY BORING TOOL HOLDER

The boring tool holder illustrated was recently designed by the Ready Tool Company, Bridgeport, Conn., for use in vertical turret lathes or boring mills where an exceptionally rigid holder is necessary. It can be furnished in two sizes: No. 1, 1¼ in. by 1¼ in by 6 in. with ½-in. square high speed cutter, and No. 2, 1½ in. by 1½ in. by 7 in. with ⅝-in. square high speed cutter. By drawing out scrap high speed tools into ½-in.- and ⅝-in. square tool bits to be used in the holders a material saving of high speed steel will be effected.



Ready Boring Tool Holder

The tool holder is designed to be used either right or left hand, and the cutter is supported on the bottom and backed up against the feed of the cut. The cutter is held by hollow set screws and there are no projecting screw heads to interfere with the proper setting of the holder in the tool post. The holder is case-hardened inside and out, making it both rigid and durable.

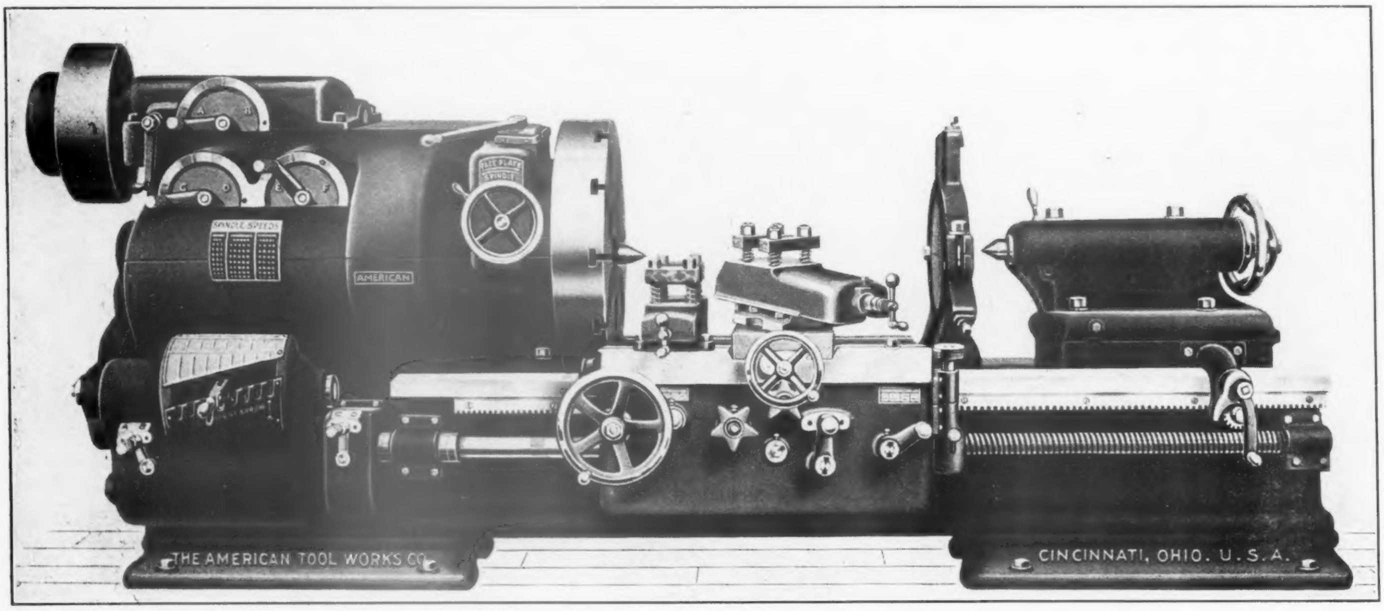
AMERICAN 36-IN. HIGH DUTY LATHE

Simplicity in machine tool design is one of the most important factors in high production. Regardless of the power, range and rigidity of a lathe, if it cannot be handled easily and quickly by the operator, or if there is a lot of unnecessary and complicated mechanism to contend with, the tool will never be an efficient producer or a money maker. With this point in mind, the American Tool Works Company, Cincinnati, Ohio, has recently designed a 36-in. heavy pattern geared head lathe particularly adaptable to railway machine shop use.

Being intended for heavy work and heavy cuts, the construction of the machine is substantial throughout and follows the standard practice of the American Tool Works Company in lathe design. The thrust bearing provided with this lathe consists of five collars alternately of bronze and hardened and ground steel. All bearings throughout the machine are furnished with renewable bronze bushings and the loose gears in the apron are also lined with bronze. The studs on which they run are casehardened and ground, thus providing a hard bearing surface without impairing the strength. The apron is of the usual double wall or box construction. The thread dial is placed at the right of the apron and can be readily disengaged from the lead screw when not in use.

The new type of patented geared head for the machine illustrated now contains only 16 gears and three shafts besides the spindle, to produce the entire range of 16 spindle speeds. These speeds are in geometrical progression and are calculated to provide a proper cutting speed for all diameters likely to be turned on a 36-in. lathe. The entire design and construction of the head makes it adaptable to the heaviest class of lathe work, such as is found in railway shops, steel mills, etc. The greatest speed reduction through the face plate drive is 237 to 1, and this unusually high ratio gives some idea of the available power. At the normal countershaft speed the belt will deliver from 30 to 35 hp.

The lathe may be arranged for motor drive by mounting a constant speed motor either of the direct or alternating current type on top of the geared head. The motor is connected to the main driving shaft through three spur gears. When apron control is furnished, the motor can be started and stopped by means of a controller handwheel conveniently located on the right end of the carriage. The size of



The American 36-In. Heavy Geared Head Lathe

the motor depends upon the nature of the work to be handled and it is usually specified by the customer after a thorough investigation of the uses to which the lathe is to be put.

All head gears run in oil. All the bearings are bronze bushed and arranged to be well lubricated. A sensitive control is provided through a large and powerful starting and stopping friction located on an extension to the initial driving shaft, which operates in conjunction with an effective brake. By this means the spindle can be quickly started and stopped, which is especially convenient for the operator when he wishes to examine his work.

The lathe can be furnished with any length of bed from 12 ft. up, advancing by 1-ft. lengths. The following are the general dimensions:

Swing over bed	37¾ in.
Swing over compound rest slide	23⅜ in.
Standard length of bed	12 ft.
12-ft. bed takes between centers, tailstock flush, geared head	5 ft. 1½ in.
12-ft. bed takes between centers, tailstock flush, cone head	5 ft. 1½ in.
Hole through spindle to clear bar	2 9/16 in.
Size of tool ordinarily used	1 in. by 2 in.
Taper of centers, Morse	No. 6
Power angular feed to compound rest	15 in.
Width of driving belt—geared head	6 in.
Diameter of driving pulley—geared head	20 in.
Speed of driving pulley, r. p. m.—geared head	475
Width of driving belt—cone head	5¾ in.

UNIVERSAL FLAT TURRET LATHE

A new universal flat turret lathe with several distinctive and meritorious features has been produced by the Acme Machine Tool Company, Cincinnati, Ohio, and is called the No. 3 Cincinnati Acme universal flat turret lathe. This machine is shown in Fig. 1 and attention is called to the cross movement provided for the turret, as well as for the auxiliary carriage, thus permitting the easy machining of work off center. Other features are the permanent alinement of the spindle with vees and cross slides, single pulley drive and sliding gear transmission. All gears run in an oil bath, are controlled by a patented gear shifting device and speeds may be changed instantly without stopping the spindle. There are safety stops in all directions and arrangement is made for power rapid traverse of the turret saddle. All controlling levers are arranged to be within convenient reach of the operator and are out of the way when lifting heavy work in or out of the chucks.

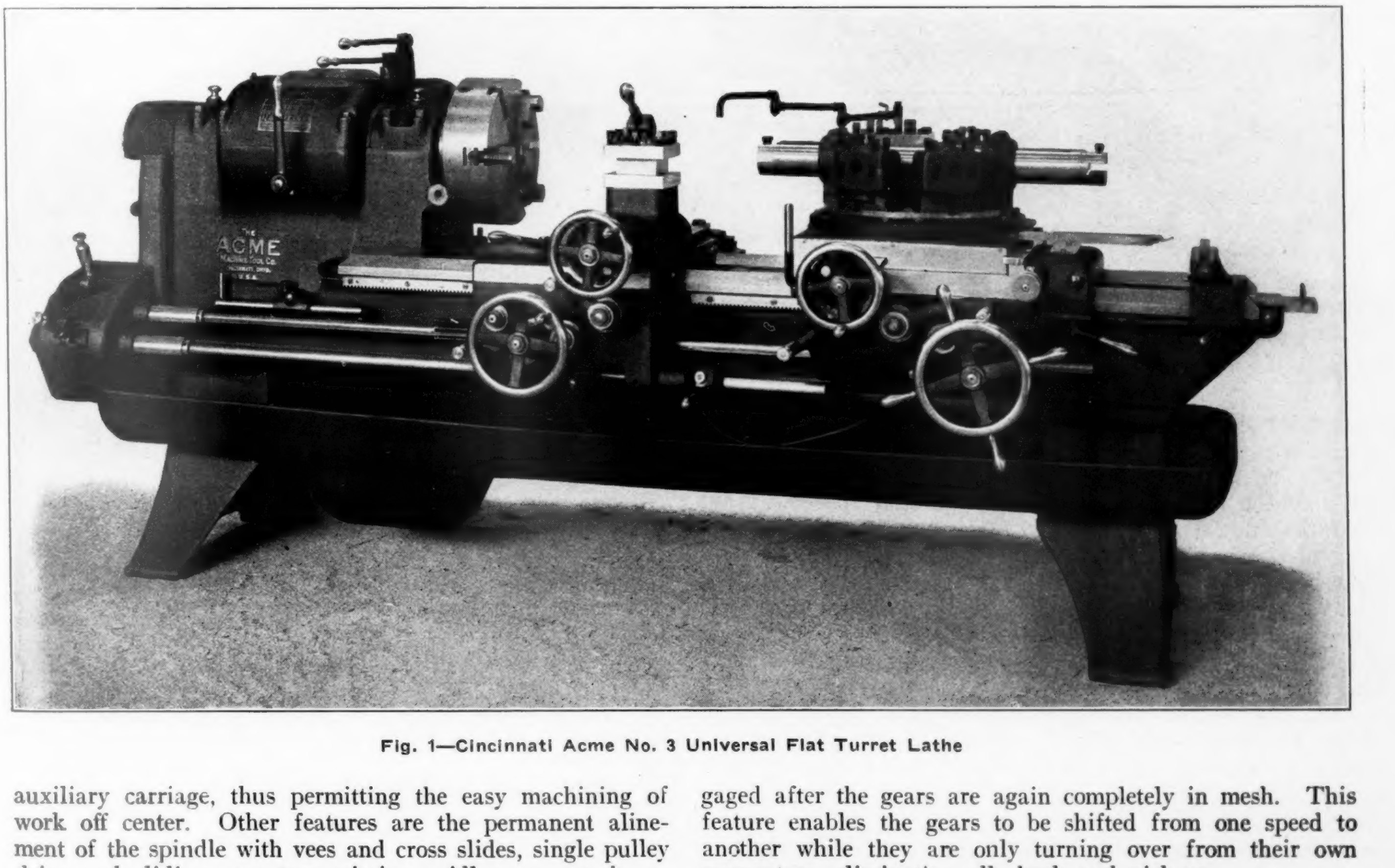


Fig. 1—Cincinnati Acme No. 3 Universal Flat Turret Lathe

This turret lathe can be furnished with an automatic chuck for bar work, or a general service chuck such as shown in Fig. 1. This chuck will accommodate work up to 17 in. in diameter and bar stock up to 3½ in. in diameter and 44 in. long. The actual swing over the bed is 24 in. The machine is especially adapted to chucking work through the advantages of the side carriage with which it is provided. This carriage permitting multiple tool operations, makes it possible to machine castings or forgings with a small number of chuckings. The carriage may also be used to advantage when doing bar work.

Every effort has been made to secure a machine as simple, accurate and rigid in construction as possible. The head is cast solid with the bed, maintaining constant and perfect alinement of spindles with the vees upon which the turret carriage travels. The ways of the bed are exceptionally large and wide. Taper gibs are furnished to take up the wear.

The geared head is simple in construction and a maximum pulling power together with nine different speeds is obtained with a small number of gears. The speeds range from 14 to 280 r.p.m., and are obtained instantly without stopping the spindle, by the use of two levers conveniently located at the front of the head. The patented gear shifting device makes possible the change from one speed to another with one continuous movement of either of the speed changing levers. When the lever has reached the point where the gears are out of mesh, the driving pulley is automatically disengaged from the driving friction and re-engaged after the gears are again completely in mesh. This feature enables the gears to be shifted from one speed to another while they are only turning over from their own momentum, eliminating all shock and pick-up.

The side carriage shown in Fig. 2 spans the ways of the bed, eliminating all overhang to the turret and tools, and is so constructed that it clears the chuck and can be moved out of the way to permit the use of short tools in the flat

turret. It is provided with six independent stops for the longitudinal movement, which are easily accessible to the operator. The square turret is mounted on the cross slide and is held in position by a hardened lock bolt, located directly above the cutting tool.

The cross sliding turret revolves on a hardened and ground stem of large diameter and is automatically locked into position by a hardened and ground tool steel taper plunger, placed directly underneath the cutting tool. This plunger works in ground taper bushings set into the solid turret and as near the outer edge as practicable. The turret is further held down at the extreme outer edge with circular clamps. Oiling arrangement is provided so that oil can be fed to each individual tool. The cross slide moves on a long, narrow, dove-tailed guide with wide flat bearing surfaces on either side and has an adjustable taper gib to compensate for wear. An adjustable hardened center stop is also provided. The cross feed can be operated in both directions by hand or power.

Power rapid traverse is provided in either direction longitudinally for the turret and is operated by a lever conveniently located at the front of the saddle. This feature creates a great saving in time and energy. Twelve

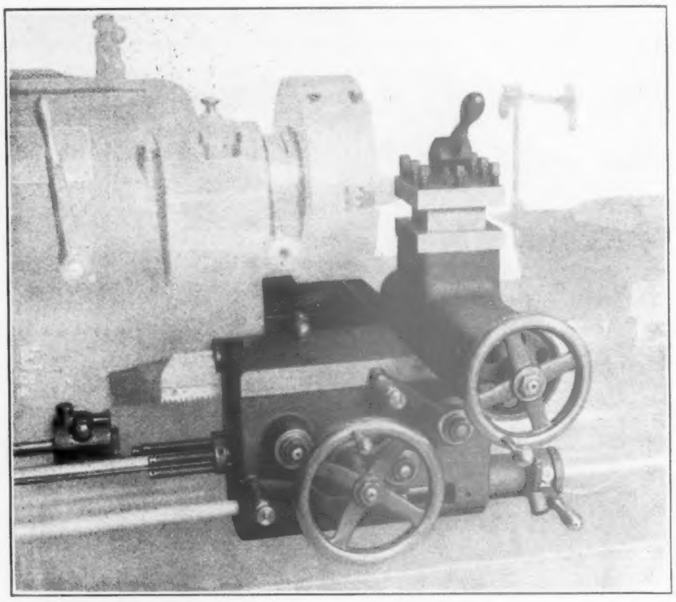


Fig. 2—Sliding Carriage Showing Apron and Independent Stops

longitudinal stops are provided, one independent stop for each turret face and six auxiliary stops, which are operated by the index knob at the right of the saddle. Power feed is provided for the cross and longitudinal movement to both the side carriage and turret. The gear box at the head end of the machine furnishes ten feeds from 10 to 240. Stops are provided for the longitudinal movement and for the cross movement a large micrometer dial with observation stops. All feeds can be reversed by operating levers conveniently placed in the aprons and within easy reach of the operator.

The bed is both deep and wide to give rigidity under heavy cuts and is strongly braced by crossed girths. The vees are exceptionally large to allow for the load of the apron and the side carriage. The pan is made deep and an oil reservoir is attached. A perforated cover serves as a strainer and allows the oil to drain back into the reservoir. A geared oil pump is furnished which provides an ample supply of oil when the machine is running in either direction. Of the two pipe lines furnished, one is for turret tools and the other for the side carriage.

A plain, tight and loose pulley countershaft is furnished and where conditions permit the use of the overhead countershaft can be avoided by belting the machine direct to the line shaft. In case a motor drive is desired a 5 to 7.5 hp. constant speed motor of 1,200 to 1,800 r.p.m. is recommended. By placing the motor on a sliding base on the floor at the head end of the machine it can be belted to the driving pulley. The general dimensions of the lathe are as follows:

Diameter can be turned	17 in.
Swing over carriage	17 in.
Swing over bed	24 in.
Hole through spindle	3¾ in.
Spindle speeds, r.p.m	14, 21, 30, 46, 66, 93, 140, 200, 280
Diameter of driving pulley	14 in.
Driving pulley, r.p.m	650
Revolution of spindle to feed turret and carriage 1 in. (cross)	10, 14, 20, 28, 40, 60, 85, 120, 170, 240
Revolution of spindle to feed turret and carriage 1 in. (long)	10, 14, 20, 28, 40, 60, 85, 120, 170, 240
Diameter of turret	18 in.
Distance from center of spindle to top of turret	4 in.
Travel of turret cross	8 in.
Travel of turret longitudinal	44 in.
Center distance between vees	14 in.
Depth of bed	12½ in.
Width of bottom of vees	2½ in.
Countershaft pulleys (tight and loose)	14 in.
Width of countershaft belt	4 in.
Countershaft pulley r.p.m	570
Floor space	3 ft. 6 in. by 11 ft. 2 in.
Weight, plain machine	net 6,750 lb.

The following equipment is furnished with the turret lathe for chucking work:

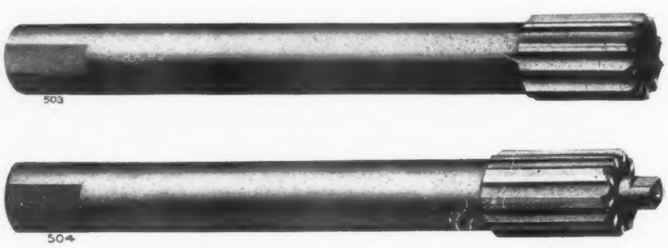
1—15 in. 3 jaw chuck with reversible jaws.
1—16 in. face plate with bolts and clamps.
2—Tool blocks.
2—Tool plates.
12—Turning cutters.
6—Boring cutters.
2—1½ in. boring bars and cutters.
1—3$\frac{7}{16}$ in. boring bar for turning and boring.
1—Extension drill support with four taper sockets for standard taper shanks.

PEERLESS REAMERS

The illustrations show two Peerless high speed reamers manufactured by the Cleveland Twist Drill Company, Cleveland, Ohio, and the special feature in their construction is the permanent setting of high speed steel blades in a carbon steel body by a process known as "Brazo-Hardening." This method secures the blades permanently in the reamer body and the work of fitting is so carefully done that only a close examination will show that the reamer is not made entirely from one piece of steel.

This gives a tool with high speed steel cutting edges and a body that is tough, resilient and difficult to break. Such a combination is impossible to obtain with a reamer made entirely of high speed steel.

Referring to the illustration, reamer No. 503 is a Peerless straight shank chucking reamer, and No. 504 is a



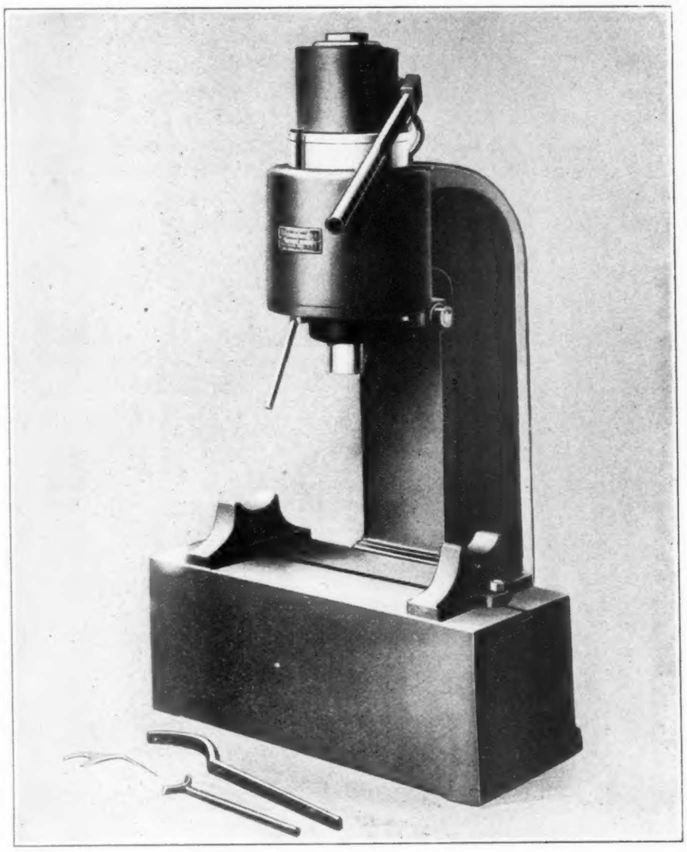
Straight Shank Peerless Reamers

straight shank expansion chucking reamer. Both of the above reamers have given good satisfaction in actual service and would be valuable in railway shops where a tough, strong tool is required and the character of the work ne-

cessitates high speed steel cutting edges. The reamers illustrated are but two of 21 different types, including expansion and turret lathe types.

HYDRAULIC BENDING PRESS

A new design of hydraulic bending and straightening press has been brought out recently by the Hydraulic Press Manufacturing Company, Mt. Gilead, Ohio. It is an item of shop equipment of particular convenience and utility, being self-contained and adaptable to a large range of uses. In railway shops the valve setters will find this press valuable for such work as bending valve rods, changing the off-set in link hangers, etc. The bed of the press is 12 in. by 32 in. and the working height is 13¾ in. The 6 in. ram has a travel of 4 in. and a rack and pinion is provided to bring it up to the work before starting the pressure pump. The pressure is applied and controlled by a hand operated pump, conveniently mounted on top of the cylinder. A forged steel cylinder is used being designed for extra heavy pressure, the maximum allowable being 5,400 lb. per sq. in. One T-slot extending the length of the bed, holds the adjustable straightening blocks. The press rests on a bench or special pedestal, and occupies a small amount of floor space.



Hydraulic Bending and Straightening Press

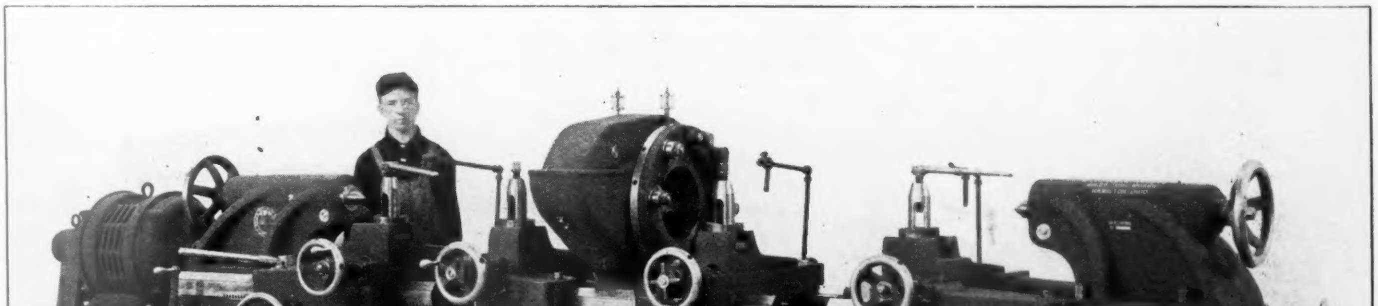
COMBINATION AXLE AND JOURNAL TURNING LATHE

In view of the increasing demand for a machine to turn car wheel journals without removing the wheels from the axles, the Niles-Bement-Pond Co. has recently developed a combined axle and journal truing lathe. The illustration shows this lathe with the upper portions of the bed pushed back, thus forming a gap to receive the wheels. The gaps on either side may easily be closed and the carriages will then travel back and forth as in the case of a common axle lathe.

The lathe is of the center drive type with the driving gear in halves and driven by a pinion carried in the bed. The center head has a hinged cap, which forms a continuous bearing for the center gear, and also completely covers the gear. The cap is clamped by one large hinged bolt and is counterweighted. Provision is made so that when the cap is swung up, it automatically lifts the top half of the main driving gear, making it easy to place in or take from the lathe an axle with or without mounted wheels. Either operation may be quickly performed.

There are four carriages on the lathe; two for the inside journal turning, and two for the outside turning. When the machine is used as an ordinary axle lathe for outside journal axles, the two outside carriages are used for turning the collars, outside journals, sand guards and wheel seats. When used as an ordinary axle lathe for inside journal axles, the two outside carriages are used for wheel seats and the two inside carriages for the journals. All four carriages are fitted with screw feeds operated by bronze open and closed nuts.

There are two tailstocks carried on the upper bed members and they each have spindles adjustable by hand wheels. The axles are driven by hinged dogs through a double



Niles-Bement-Pond Combination Axle and Journal Turning Lathe

equalizer drive plate of a similar type to that used on the standard Niles-Bement-Pond axle lathe.

There are three changes of feed from 1/12 in. to 1/4 in. provided for the carriages, the adjustment being made by means of a pull pin. The machine is fitted with a pump and suitable drainage system.

In case it is desired to drive the lathe from overhead shafting a two speed counter shaft is furnished and a three step cone pulley gives six speeds to the driving head, ranging from 16 to 48 r.p.m.

The same speed variation may also be obtained by means of a 15-hp. direct or alternating current motor. In this case the motor is mounted on a base plate attached to the left hand end of the bed and is geared directly to the driving shaft.

The principal dimensions of the lathe are as follows:

Swing over lower bed or sole plate	45 in.
Swing over upper bed	30 in.
Swing over carriage	15 in.
Maximum distance between centers	7 ft. 9 in.
Main bearing diameter	16 in.
Main bearing length	13 in.

FOSTER UNIVERSAL TURRET LATHE

The machine illustrated in Fig. 1 is a new combination turret lathe for both bar and chucking work, known as the 2-B universal turret lathe, built by the Foster Machine Company, Elkhart, Ind. This turret lathe is designed to handle bar work up to 3 1/4 in. in diameter and 30 in. in length, and clucking work up to 15 in. in diameter. Due to the larger swing over the horns of the carriage, however, it is possible to handle light chucking work up to 20 in. in diameter. The machine is called universal on account of its adaptability to widely varying kinds of work, its extensive and well-balanced speed and feed ranges, and numerous standard and special tool attachments.

Twelve speed changes ranging from 12 to 325 r.p.m. are obtained by means of sliding gears in the lathe head. These gears run in an oil bath and all bearings in the head are automatically lubricated by the splash from the gears. The levers for operating the speed and feed changes are mounted conveniently on top of the head cover as shown in Figs. 1 and 2. The start, stop and reverse friction clutch is mounted on the back gear shaft and operated by the lever shown directly over the front spindle box.

The lathe bed is well proportioned and heavily ribbed internally, which makes it capable of resisting heavy cutting strains without vibration or deflection. A four-in. belt running at a speed of 1,960 ft. per minute delivers to the machine 8 1/2 hp., which is sufficient to allow four or five simultaneous cuts to be taken with a comparatively coarse feed. The friction clutch is well designed and capable of transmitting about twice the above load. The sliding gears in the head are of the Fellows stub tooth type.

The cross slide carriage is shown in Fig. 2. The rear end of the cross slide is built in the shape of a table on which standard or special tool holders may be mounted. The square turret mounted on the cross slide is indexed and locked by means of the lever handle shown at the top. The lock bolt which is of the cylindrical, vertically mounted type, is located directly underneath the working position of the cutting tool. Fig. 3 shows in detail the screw cutting attachment and the six carriage stops.

The six independent and adjustable stop screws are mounted on an index stop spool and are used for the purpose of longitudinal gaging and duplicating the work. For duplicating and gaging diameters of the work a large diameter dial is mounted on the cross speed screw and it also has adjustable observation stops. The cross speed is disengaged by means of the short lever shown pointing to the right on the carriage apron.

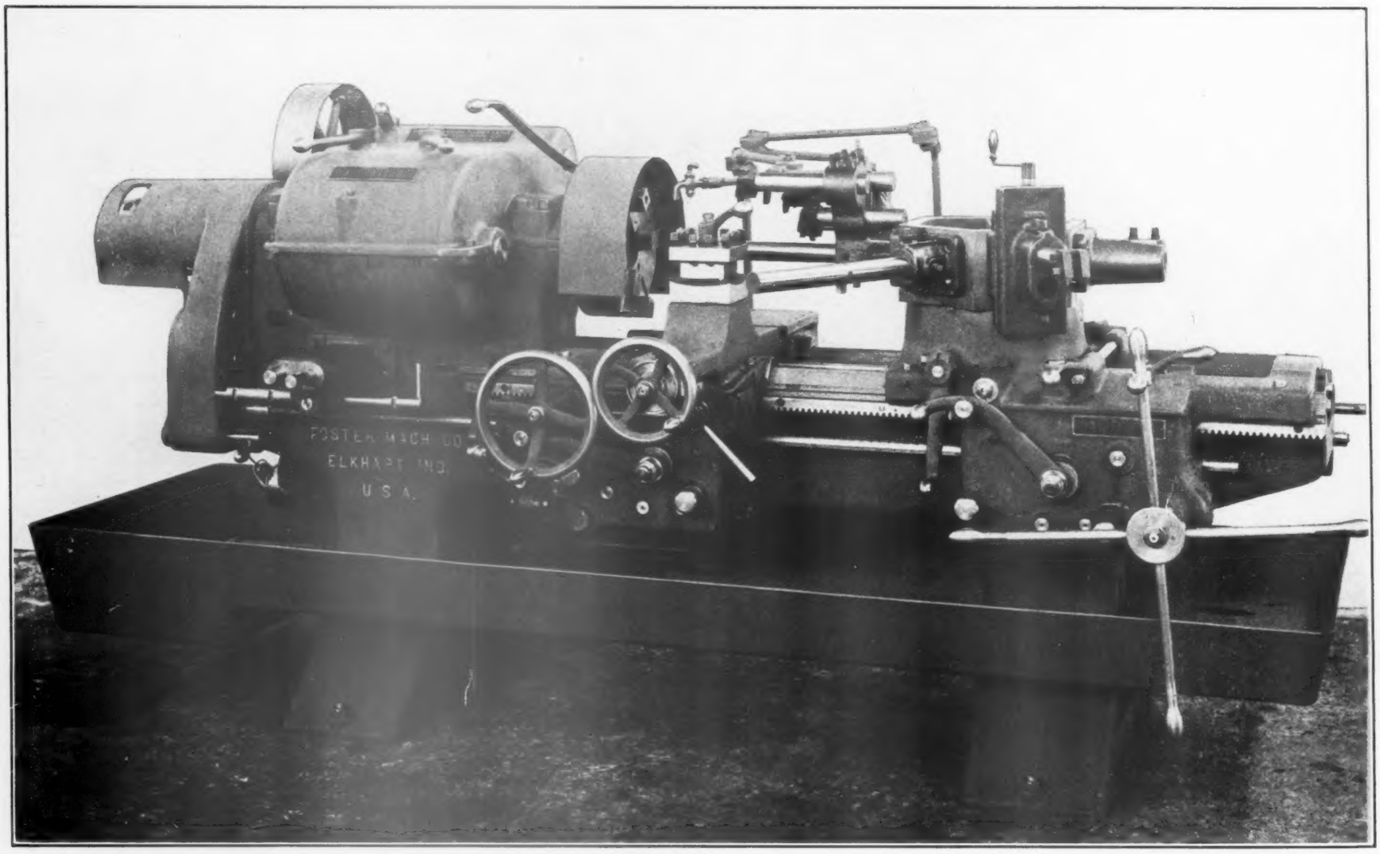


Fig. 1—Foster 2-B Universal Turret Lathe with Chucking Equipment

Twelve speed changes for the longitudinal feed range from

.0055 in. to .15 in. per spindle revolution. The range for cross feed is from .0029 in. to .080 in. per spindle revolution.

The main turret is of the hollow hexagon type, well proportioned and shown in Fig. 4 with bar tools mounted and ready for operation. The turret saddle has an exceptionally long bearing on the bed and the apron is similar to the one used on the cross slide. The drop off feed friction which

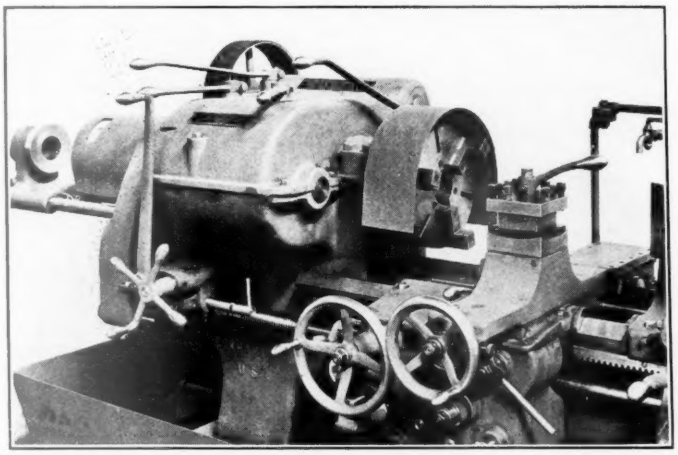


Fig. 2—Lathe Head, Cross Slide and Carriage

is automatically disengaged in a manner similar to that operating the feed friction for the carriage apron is here controlled by adjustable stops mounted on a long stop roll located between the ways of the bed. This stop roll is long enough to take care of work up to the maximum capacity of the machine.

An important feature is the quick traverse mechanism consisting of a right and left hand screw with engaging units mounted on the back of the lathe and operated by means of a lever from the front side. An adjustable rod, mounted on a bracket secured to the rear end of the bed,

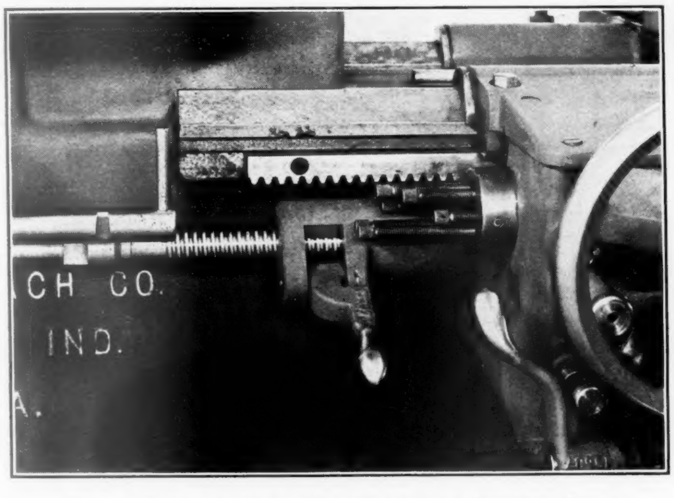


Fig. 3—Screw Cutting Attachment and Carriage Stops

automatically disengages the quick traverse and thus limits the movement of the saddle. The quick traverse screw is fully protected from chips and dirt and is driven by a belt from the main driving pulley.

If desired, the machine can be equipped with screw cutting and taper attachments. The screw cutting attachment plainly shown in Fig. 3 is mounted on the main feed rod and is capable of cutting two pitches of thread in the multiples of one and four of that of the pitch of the leader. The follower is mounted in a lever in a projection of the carriage apron. The taper attachment which is of rigid construction is mounted on the rear end of the carriage and operates directly on the cross feed nut. The adjustment of this attachment is very simple and requires only a minimum amount of time.

For automatic chuck and bar feed work, a chuck of the standard collet type may be furnished. This chuck has a short overhang beyond the front spindle bearing. A new method has been devised for operating the chuck wedge which not only makes the chuck easier to operate but increases its gripping power. The bar feed head travels on two parallel bars, the outer ends of which are supported in a rigid stand. Extensive and complete tool equipment for both bar and chucking work are designed for the Foster turret lathe. Fig. 1 shows a few special chucking tools mounted on the turret head, but Fig. 4 shows the ones most commonly used.

The machine can be driven either from a countershaft or by means of an individual motor, which is usually mounted on the back ledge of the machine where it will be out of the way. A special study has been made of the method

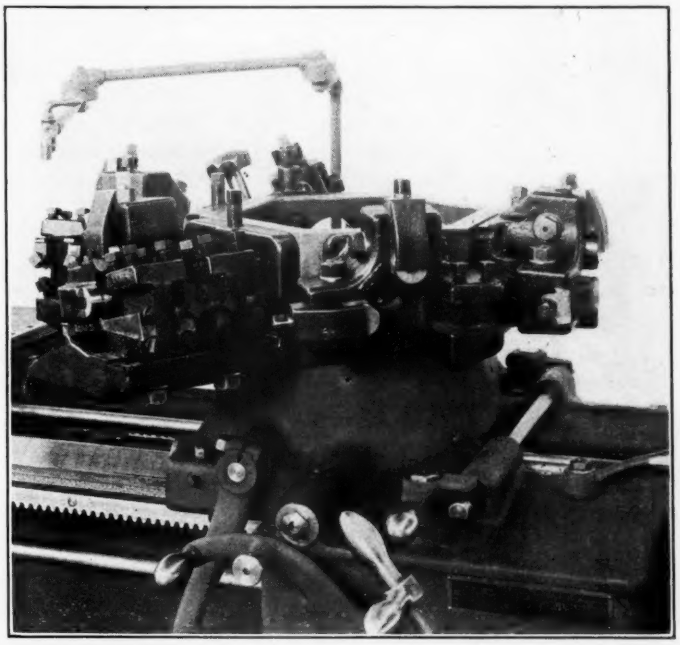


Fig. 4—Hexagon Turret and Saddle with Bar Tools

of supplying the cooling compound and by means of a pump and pipes shown in Figs. 1 and 4, an ample supply is at all times available.

This lathe with automatic chuck and bar feed attachments weighs 5,200 lb.

GERMANY SELLS LOCOMOTIVES.—Despite the alleged deficiencies of the German railways in respect to rolling stock, Germany still finds it possible to manufacture locomotives for export, according to an Associated Press correspondent at Stockholm in a report dated March 25, and quoted in the New York Times. Two of an order of twenty for the Swedish State railways were received the first week in March, and the other eighteen were promised before April 1. The scarcity of brass and copper in Germany is evidenced by the fact that nearly all locomotive parts usually made of these metals are made of iron or steel in the locomotives already received. The Swedish State railways have also closed a contract with the German steel trust for 80,000 tons of rails, with plates and bolts. One-third of the order is to be delivered this year, a third is to be delivered in 1919, and the rest will be delivered in 1920.

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WE GUARANTEE, that of this issue 10,000 copies were printed; that of these 10,000 copies 5,640 were mailed to regular paid subscribers, 138 were provided for counter and news companies' sales, 330 were mailed to advertisers, 169 were mailed to exchanges and correspondents, and 3,723 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 49,400, an average of 8,233 copies a month.

The RAILWAY MECHANICAL ENGINEER is a member of the Associated Business Papers (A. B. P.) and of the Audit Bureau of Circulations (A. B. C.).

Colonel Wildurr Willing of the 12th Engineers (Railway) has acknowledged receipt under date of April 10, of two shipments of tobacco from the Railway Regiments' Tobacco Fund. He states that "This tobacco was divided among the enlisted personnel of the regiment, and I am sure the men have had no greater treat since entering the service of the government."

Employees of the Pennsylvania Railroad System in the military and naval service on April 1, last, numbered 12,548; and 8,415 of the names of these men are printed in a statement, filling 42 pages, of the Mutual Magazine, published by the employees of the Pennsylvania Railroad. This number of the magazine (May) has for its frontispiece a full length portrait of Brigadier-General W. W. Atterbury.

"Safe Practice" in the management of shafting, couplings, pulleys and gearing is the title of the National Safety Council's illustrated Pamphlet No. 8, which has recently been issued. It consists of eight pages, and the price is 10 cents. No. 9 deals with engine guarding and engine stops, automatic governors, etc., 16 pages; No. 10 is on oiling devices and oilers, eight pages. All of these are to be had from W. H. Cameron, general manager, National Safety Council, Chicago.

The locomotive boiler inspectors of the government will receive substantial increases of salary, if Congress accepts a report recently presented in the House by the Committee on Interstate and Foreign Commerce. By the bill as reported the chief inspector will be advanced from $4,000 to $5,000; two assistant chief inspectors from $3,000 to $4,000; and fifty district inspectors from $1,800 to $3,000. The report says that the legislative agents of the brotherhoods of enginemen, conductors and firemen, supported the bill.

The Division of Valuation of the Interstate Commerce Commission wants senior electrical engineers, grade 2; junior civil engineers, grade 1; and junior engineers in the same grade for the electrical, mechanical, signal, structural, telegraph and telephone departments; also junior architects. Candidates for senior electrical engineer will have their applications considered on June 18, while those for the other offices named will be taken up at any time, regardless of date. The salaries for the first named office will range from $1,800 to $2,700; and for the other places, from $1,320 to $1,680.

The New York legislature has passed a law requiring all new locomotives which shall be put in service after this year (1918) and all taken into the shop after January 1, next, for general repairs, to be equipped with "vestibuled" cabs, so constructed as "to attach to the sides of and inclose all openings between the engine cab and the tender." The New York law requiring power-operated fire doors on locomotives goes into effect on the same date on all new locomotives placed in service after January 1, next, and locomotives now in service must be equipped with vestibules the next time they are withdrawn for "generally heavy repairs," after the act becomes effective next January.

Director General McAdoo has instructed that the order of the Interstate Commerce Commission which requires that locomotives be equipped with high power headlights be fully observed by all railroads. Some of the roads have been holding in abeyance the equipment of their locomotives with headlights to meet the requirements of this order, pending the outcome of court proceedings. The director general's instructions that the terms of the order be carried out in good faith means that all locomotives not now equipped with headlights to meet the requirements of rules 29 and 31 of the Interstate Commerce Commission will be so equipped as fast as locomotives are shopped for general repairs.

The University of Illinois, at its summer session, June 17 to August 9, will offer special advanced courses in the mechanics and properties of materials of construction and in materials testing, planned especially for instructors in mechanics, for chemists who wish to fit themselves to take positions involving the physical testing of materials, and for men who wish to fit themselves for positions in commercial or government testing laboratories. The extensive equipment of the Testing Laboratory of the University will be available for this work, which will be under the charge of Prof. H. F. Moore. Taken together, these courses will constitute a short course of intensive training for men who desire to qualify as testing engineers in the government service or elsewhere.

The Rock Island Lines plan to send a "smoke kit" to each of the 2,074 Rock Island men now in army and navy service. Ever since last summer money has been coming in for Company B, of the Thirteenth Engineers (Railways),

which has been in France since early last fall. So far about $2,200 worth of "smokes" and other articles of comfort have been sent to the men in this company, and in addition $2,275 has been cabled to the company as a mess fund. It is now proposed to send a kit containing tobacco, candy and other comforts to all other Rock Island men now with the colors. The May shipment to Company B cost $461 and consisted of 12,000 Fatima cigarettes, 720 packages of Tuxedo tobacco, 864 packages of Prince Albert, 100 books of cigarette paper, 1,440 pieces of chewing tobacco, 10 dozen packages of pipe cleaners; 3,132 cigars, 180 lb. candy, 6,000 envelopes and 18,000 sheets of letter paper.

Canadian Orders for Cars and Engines

A statement of recent orders for equipment, presented in Parliament at Ottawa on April 9, by Hon. J. D. Reid, Minister of Railways, shows the following contracts:

Canada Car & Foundry Company, 5,000 forty-ton steel frame box cars, $13,750,000; National Steel Car Company, 1,000 cars, $2,750,000; Eastern Car Company, 750 forty-ton flat cars $1,777,800; Eastern Car Company, 650 fifty-ton coal cars, $2,066,675; Hart-Otis Company, 250 side-dump cars, $760,000; Hart-Otis Company, 200 side and center-dump cars, $625,000; Pressed Steel Car Company, 25 general service tanks, $134,956; Pressed Steel Car Company, 25 water service tanks, $129,593; Canada Car & Foundry Company, 250 refrigerator cars, $1,024,250; Pullman Car Company, 14 sleeping cars, $502,460; Pullman Car Company, 7 dining cars, $238,700; Montreal Locomotive Works and Canada Locomotive Company, 50 Consolidation freight engines, $2,900,000; 10 switching engines, $405,000; 30 Pacific type engines, $1,800,000; 60 Mikado type engines, $3,720,000, Canada Locomotive Company, six switching engines, $246,000; four narrow gauge engines, $136,080. Total cost of all equipment ordered, $32,966,515. This does not include the 100,000 tons of rails recently purchased.

In reply to a question, Dr. Reid said he might yet have to purchase ten or fifteen snow ploughs at a cost of $100,000, while the National Railway Defense Association was asking him to buy 100 tourist cars for carrying troops. He might also have to purchase 19 baggage cars.

M. C. B. Circulars

The Executive Committee of the Master Car Builders' Association has issued circular No. 40 requesting that the placing of reporting marks on freight cars between two horizontal bars be considered as a standard of the association.

Circular No. 43 is a price list of the publications of the association. Copies of the Proceedings may be had at $7.50 per copy, net. The Rules of Interchange are furnished at the following rates, to which postage should be added when sent by mail:

100 or more copies	$6.00
50 copies	3.25
25 copies	2.00
Single copies	.10

The revised Loading Rules are sold at the following set prices:

100 or more copies	$6.00
50 copies	3.25
25 copies	2.00
Single copies	.10

The revised Specifications for Tank Cars may be secured at the following net prices:

100 or more copies	$7.50
50 copies	4.00
25 copies	2.00
Single copies	.10

A supply of the book containing the United States Safety Appliance requirements is still available at 25 cents per copy, f. o. b. Chicago. The supply of the bound volumes of the decisions of the Arbitration Committee, Cases 1 to 788, inclusive, is exhausted. A volume containing an abstract of Cases 1 to 942, inclusive, is available, at 50 cents per copy, including postage if sent by mail. Cases 789 to 1132 are in pamphlet form, and are furnished free of charge.

The Car and Locomotive Orders

The United States Railroad Administration announced early in the month of May the placing of orders for 100,000 freight cars, to be built to its standard specifications, including 50,000 box cars, and 50,000 hopper and gondola coal cars, divided between 17 car building companies, and 1,025 locomotives also of its standard types, 555 from the American Locomotive Company and 470 from the Baldwin Locomotive Company.

The total cost of the cars is placed at from $250,000,000 to $300,000,000 and of the locomotives at approximately $60,000,000, although the specialties have not yet been awarded and the final detailed contracts have not yet been executed. It is understood that 145 additional locomotives are to be awarded to the American Locomotive Company, and 30 to the Baldwin Locomotive Works, in about 60 days, and that approximately 1,000 additional locomotives and about 100,000 additional cars are to be ordered in about six months.

Cars.—The distribution of the order by companies and types is as follows:

American Car & Foundry Co.	10,000	40-ton double sheathed box
	9,000	50-ton single sheathed box
	5,000	50-ton composite gondola
	6,000	55-ton hopper
Pressed Steel Car Co.	6,500	50-ton composite gondola
	5,000	55-ton hopper
	2,500	70-ton low side gondola
Standard Steel Car Co.	2,000	40-ton double sheathed box
	5,500	50-ton composite gondola
	5,000	55-ton hopper
	2,500	70-ton low side gondola
Pullman Co.	6,000	50-ton single sheathed box
	2,000	55-ton hopper
Haskell & Barker Car Co.	6,000	50-ton single sheathed box
	2,000	50-ton composite gondola
Ralston Steel Car Co.	4,000	55-ton hopper
Cambria Steel Co.	3,000	55-ton hopper
Magor Car Corporation	1,000	50-ton composite gondola
St. Louis Car Co.	1,000	50-ton single sheathed box
Mt. Vernon Car Co.	4,000	40-ton double sheathed box
Pacific Car & Foundry Co.	2,000	40-ton double sheathed box
Liberty Car & Equipment Co.	1,000	40-ton double sheathed box
Keith Car Mfg. Co.	1,000	40-ton double sheathed box
Laconia Car Co.	1,000	40-ton double sheathed box
Bettendorf Co.	3,000	50-ton single sheathed box
Lenoir Car Works	2,000	40-ton double sheathed box
Barney & Smith Car Co. (pending)	2,000	40-ton double sheathed box
Total	100,000	

Locomotives.—The locomotive order was divided, 555 to the American Locomotive Company and 470 to the Baldwin Locomotive Works as follows:

American	Baldwin	Type
217	183	Light Mikado
70	30	Heavy Mikado
20	15	Light Mountain
3	2	Heavy Mountain
10	20	Light Pacific
10	10	Heavy Pacific
75	75	Light 2-10-2
25	10	Heavy 2-10-2
30	20	Six-wheel switching
75	75	Eight-wheel switching
15	15	(2-6-6-2) Mallet
5	15	(2-8-8-2) Mallet

This order will be increased probably before July 1 to 1,200, the American Locomotive Company being given 145 more locomotives to make 700 locomotives, and the Baldwin Locomotive Works 30 more, to make 500.

Prices.—The car orders were all placed upon the basis of the minimum bids as to costs for labor and materials with the understanding that any reduction in costs which may be obtained from these fixed prices will be divided equally between the Railroad Administration and the car builders, but any increase in these costs will be borne exclusively by the builders. The government will have supervision or control

as to the prices of the materials required in construction and in cases where the government has fixed prices these will be the maxima, but an effort is to be made to secure steel and other materials at prices below those previously fixed. In this case the builder will have an opportunity to share in the saving.

The compensation of the builders in the case of both cars and locomotives will be approximately 5 per cent on the cost, as estimated on the minimum bid. The contracts with the locomotive builders provide that the government guarantee the cost of material and that if any saving is made on the estimates other than that on the material, that it be divided equally between the government and the builders.

In the case of the locomotives, the announcement stated that deliveries are to begin in July and continue monthly during the remainder of the year, and in the case of the cars that it is hoped that the entire order will be completed in time for the fall and winter business of the railroads.

As this issue goes to press the orders for the specialties and appliances are being placed. One of the first distributions was that for draft gear, announced about June 3. The 100,000 cars are divided as follows: Sessions, 50,000; Westinghouse, 20,000; Cardwell, 15,000; Miner, 10,000, and Murray, 5,000.

M. C. B. and M. M. Associations

The Executive Committees of the Master Car Builders' and the Master Mechanics' Association, at a joint meeting held in Chicago on May 13, elected V. R. Hawthorne secretary of both associations, to fill temporarily the vacancy caused by the death of Joseph W. Taylor. Mr. Hawthorne was born at Oleona, Pa., on November 27, 1886. He entered the service of the Pennsylvania Railroad as a car repairman at the Elmira, N. Y., shops in June, 1905. He was transferred to the shops at Baltimore, Md., in November of the same year, at which place he was employed during the summer months repairing passenger cars and during the winter as a clerk. Here he gained his first experience in M. C. B. billing. In June, 1910, he was transferred to Williamsport, Pa., as M. C. B. clerk in the office of J. T. Wallis, remaining there until June, 1914, at which time he was transferred to Altoona, Pa., as a gang leader in the M. C. B. clearing house. While there he was appointed on the M. C. B. special committee making time studies. Early in 1917 he was appointed special master car building inspector, reporting to J. T. Wallis, general superintendent of motive power of the Pennsylvania Railroad. He was assigned on special M. C. B. committee work of the American Railway Association in April, 1917.

V. R. Hawthorne

MEETINGS AND CONVENTIONS

Society for Testing Materials.—The twenty-first annual meeting of the American Society for Testing Materials will be held at the Hotel Traymore, Atlantic City, N. J., on June 25, 26, 27 and 28. Wednesday afternoon, the 26th, will be devoted to topical discussions on Co-operation in Industrial Research, while the evening session on Thursday will be a joint meeting with the American Concrete Institute. The annual golf tournament will be held on Thursday afternoon.

Western Railway Club.—At the annual meeting of the Western Railway Club held at the Hotel Sherman, Chicago, on May 20, the following officers were elected: President, A. LaMar, master mechanic, Pennsylvania Lines; first vice-president, G. S. Goodwin, mechanical engineer, Chicago, Rock Island & Pacific; second vice-president, W. Alexander, superintendent of motive power, Chicago, Milwaukee & St. Paul; treasurer, C. H. Bilty, mechanical engineer, Chicago, Milwaukee & St. Paul.

Master Car Builders' and Master Mechanics' Associations.—The Master Car Builders' Association and the American Railway Master Mechanics' Association has issued a joint circular postponing the annual conventions of the associations another year, and calling a meeting to dispose of the accumulated work of committees and to pass on other matters requiring action. All representative members, the chairmen of all committees, the executive committees of both associations, and the arbitration committee of the Master Car Builders' Association are invited to attend the meeting, which will be held in the Florentine Room of the Congress Hotel, Chicago, on June 19 and 20, 1918.

The Master Car Builders' Association will receive reports from the committees on the following subjects: Arbitration; standards and recommended practice; brake shoe and brake beam equipment; couplers; loading rules; car wheels; specifications and tests for materials; train lighting and equipment; tank cars, and welding truck side frames, bolsters and archbars.

Committees of the Master Mechanics' Association will present reports on the following subjects: Standards and recommended practice; mechanical stokers; fuel economy and smoke prevention; specifications and tests for materials; train resistance and tonnage rating; springs (shop manufacture and repair).

The reports of the committees will not be sent out to the members in advance of the meeting but copies will be distributed to those attending. The associations will maintain headquarters at the Congress Hotel. There will be no exhibit.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations:

AIR BRAKE ASSOCIATION.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

AMERICAN RAILROAD MASTER TINNERS', COPPERSMITHS' AND PIPEFITTERS' ASSOCIATION.—O. E. Schlink, 485 W. Fifth St., Peru, Ind.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.—V. R. Hawthorne, Karpen Bldg., Chicago. Meeting, June 19 and 20, Congress Hotel, Chicago.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—R. D. Fletcher, Belt Railway, Chicago.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Prof. E. Marburg, University of Pennsylvania, Philadelphia, Pa. Annual meeting June 25-28, 1918, Hotel Traymore, Atlantic City, N. J.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 841 Lawler Ave., Chicago. Second Monday in month, except June, July and August, Hotel Morrison, Chicago.

CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.—W. R. McMunn, New York Central, Albany, N. Y.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—A. L. Woodworth, C. H. & D., Lima, Ohio.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—J. G. Crawford, 542 W. Jackson Blvd., Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1126 W. Broadway, Winona, Minn.

MASTER BOILERMAKERS' ASSOCIATION.—Harry D. Vought, 95 Liberty St., New York.

MASTER CAR BUILDERS' ASSOCIATION.—V. R. Hawthorne, Karpen Bldg., Chicago. Meeting, June 19 and 20, Congress Hotel, Chicago.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION OF U. S. AND CANADA.—A. P. Dane, B. & M., Reading, Mass.

NIAGARA FRONTIER CAR MEN'S ASSOCIATION.—George A. J. Hochgrebe, 623 Brisbane Bldg., Buffalo, N. Y. Meetings, third Wednesday in month, Statler Hotel, Buffalo, N. Y.

RAILWAY STOREKEEPERS' ASSOCIATION.—J. P. Murphy, Box C, Collinwood, Ohio.

TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, N. Y. C. R. R., Cleveland, Ohio. Next meeting, September 10, 1918, Chicago.

PERSONAL MENTION

GENERAL

J. BENZIES, supervisor of fuel economy of the Chicago terminal, Illinois and Missouri divisions of the Chicago, Rock Island & Pacific, with headquarters at Rock Island, Ill., now has charge of the Chicago terminal and the Illinois divisions, with the same headquarters. This change is due to a rearrangement of territories assigned to supervisors of fuel economy.

PAUL A. BEVAN, motive power inspector, Central System, Pennsylvania Railroad, Western Lines, has been granted a furlough to enter the Ordnance Department of the United States Army, as engineer of tests. Mr. Bevan is located at the United States Cartridge Company, Lowell, Mass.

E. W. SMITH, master mechanic of the Philadelphia division of the Pennsylvania Railroad, with office at Harrisburg, Pa., has been appointed superintendent of motive power of the Central division to succeed Elliot Sumner, who has been transferred. Mr. Smith was born at Charlesburg, W. Va., on September 21, 1885. He is a graduate of the Virginia Polytechnic Institute, and he entered the service of the Pennsylvania Railroad on August 1, 1906, as a special apprentice. On July 26, 1909, he was made motive power inspector, was advanced to motive power foreman on September 1, 1912, and on October 15, 1913, he was appointed assistant master mechanic at the Altoona machine shops. On July 1, 1916, he was advanced to the position of assistant engineer of motive power in the office of the general superintendent of motive power at Altoona, which position he held until October 10, 1917, when he was appointed master mechanic of the Philadelphia division.

E. W. Smith

B. J. BONNER, road foreman of equipment of the Chicago, Rock Island & Pacific, with headquarters at Herington, Kan., has been appointed supervisor of fuel economy of the East Iowa, Cedar Rapids and Minnesota divisions, with headquarters at Cedar Rapids, Iowa.

F. CONNOLLY, supervisor of fuel economy of the St. Louis, Kansas City terminal, Kansas and El Paso divisions of the Chicago, Rock Island & Pacific, with headquarters at Herington, Kan., now has charge of the Kansas and El Paso divisions, with the same headquarters.

R. FERNANDEZ has been appointed locomotive inspector of the Cuba Railroad, with headquarters at Camaguey, Cuba.

E. S. FITZSIMMONS, mechanical superintendent of the Erie, with office at New York, has resigned to go into other business.

WILLIAM S. JACKSON, master mechanic of the Erie at Marion, Ohio, has been appointed mechanical superintendent of the Erie, with headquarters at New York, to succeed F. S. Fitzsimmons. Mr. Jackson was born on August 12, 1878. He began railway work on August 16, 1892, with the Lake Shore & Michigan Southern and served to July, 1911, consecutively as engine despatcher, roundhouse foreman and general foreman. He then went to the Interstate Commerce Commission as locomotive boiler inspector, and later was made locomotive inspector at Cleveland, Ohio, until January, 1917, when he entered the service of the Erie as general inspector. In August of the same year he became master mechanic of the Kent division at Marion, Ohio, which position he held at the time of his recent appointment as mechanical superintendent as above noted.

A. R. KIPP, mechanical superintendent of the Chicago division of the Minneapolis, St. Paul & Sault Ste. Marie, with headquarters at Fond du Lac, Wis., has been transferred to Minneapolis, Minn.

EUGENE MCAULIFFE, president of the Union Colliery Company and formerly general coal agent of the Frisco Lines, has been appointed manager of the Fuel Conservation Section, Division of Transportation of the United States Railroad Administration, and will give attention to the conservation of fuel on all roads, with special reference to its preparation and proper use. He will also investigate and make recommendations in connection with its transportation to and handling at fuel stations; Major Edward C. Schmidt now with the Fuel Administration, has been appointed an assistant to Mr. McAuliffe, who will have headquarters both at Washington and at St. Louis.

F. MEREDITH, supervisor of fuel economy of the Iowa, Nebraska and Colorado divisions of the Chicago, Rock Island & Pacific, with headquarters at Fairbury, Neb., now has charge of the West Iowa, Nebraska and Colorado divisions, with the same headquarters.

F. P. PFAHLER, master mechanic of the Baltimore & Ohio at Cumberland, Md., has been appointed mechanical engineer of the Locomotive Section, United States Railroad Administration.

H. S. WALL, whose appointment as mechanical superintendent of the Atchison, Topeka & Santa Fe, with headquarters at Los Angeles, Cal., was announced in the *Railway Mechanical Engineer* for May, has been in the employ of the Atchison, Topeka & Santa Fe for a period of nearly 19 years. On October 5, 1899, Mr. Wall entered the services of that company as a machinist at Albuquerque, N. M., and on April 1, 1900, he was appointed round-house foreman at Needles, Cal. On July 1 of the same year he was promoted to general foreman at the same place, and on August 15, 1900, he was promoted to division foreman at Barstow, Cal. He remained there until May 1, 1906, when he was promoted to master mechanic at Winslow, Ariz., being transferred on October 21 of the same year to Needles, Cal. On July 1, 1909, he became shop superintendent at San Bernardino, Cal., which

H. S. Wall

position he held until his recent appointment as mechanical superintendent of the Coast Lines as mentioned above.

C. W. REED, road foreman of equipment of the Chicago, Rock Island & Pacific, has been appointed supervisor of fuel economy of the Missouri, Kansas City terminal and St. Louis divisions, with headquarters at Trenton, Mo.

R. SANCHEZ has been appointed air brake instructor of the Cuba Railroad, with headquarters at Camaguey, Cuba.

E. C. SASSER, superintendent of motive power of the Southern Railway, with office at Charlotte, N. C., now has jurisdiction over the entire lines east; W. S. Murrian, having resigned to engage in other business, the position of superintendent of motive power of the middle district has been abolished.

P. SMITH, supervisor of fuel economy of the Cedar Rapids, Minnesota, Dakota and Des Moines divisions of the Chicago, Rock Island & Pacific, with headquarters at Cedar Rapids, Iowa, now has charge of the Dakota and Des Moines Valley divisions, with headquarters at Valley Junction, Iowa.

ELLIOT SUMNER, superintendent of motive power of the Central division of the Pennsylvania Railroad, with office at Williamsport, Pa., has been appointed superintendent of motive power of the New Jersey division, with headquarters at New York. Mr. Sumner succeeds F. G. Grimshaw, promoted.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

G. H. BERRY has been appointed assistant master mechanic of the South Louisville (Ky.) shops of the Louisville & Nashville, succeeding B. E. Dupont, transferred.

C. H. BLAKE has been appointed road foreman of engines on the Southern Kansas division of the Atchison, Topeka & Santa Fe, with headquarters at Chanute, Kan., succeeding W. A. Moon, assigned to other duties.

R. V. BLOCKER, general foreman of the Erie at Huntington, Ind., has been appointed master mechanic, with office at Marion, Ohio, to succeed W. S. Jackson.

A. B. CLARK, master mechanic of the Chicago Great Western at Oelwein, Iowa, has been appointed master mechanic at Des Moines, Iowa.

C. W. CULVER, general foreman of the Central of New Jersey at Mauch Chunk, Pa., has been appointed assistant master mechanic of the Lehigh and Susquehanna division, with office at Mauch Chunk.

B. E. DUPONT has been appointed master mechanic of the Howell (Ind.) shops, Henderson and St. Louis divisions and St. Louis terminals of the Louisville & Nashville, succeeding Henry Hardie, deceased.

A. B. ENBODY, assistant master mechanic of the Central of New Jersey, with office at Mauch Chunk, Pa., has been appointed master mechanic of the Lehigh and Susquehanna division in charge of locomotive and car departments, and assignment of power, with office at Ashley, Pa.

C. GRIBBIN, master mechanic of the Canadian Pacific at North Bay, Ont., has been appointed master mechanic of the New Brunswick district, with office at St. John, N. B., succeeding C. Kyle, transferred.

T. HAMBLEY, division master mechanic of the Canadian Pacific at Sudbury, Ont., has been appointed master mechanic at North Bay, Ont., succeeding C. Gribbin.

S. W. HECKATHORNE has been appointed master mechanic of the Anthony & Northern, with headquarters at Pratt, Kan., succeeding S. C. Reep.

J. A. MCFERRAN, master mechanic of the Louisville & Nashville, at Covington, Ky., has been appointed master mechanic of the Mobile and Montgomery division and branches, with office at the Montgomery (Ala.) shop. The position of T. A. Nelson, assistant master mechanic at Montgomery, has been abolished.

C. W. MATTHEWS has been appointed master mechanic of the Cincinnati terminals and Kentucky division of the Louisville & Nashville, with offices at Central Covington (Ky.) shop, succeeding J. A. McFerran.

H. M. OAKES, formerly master mechanic of the Missouri, Kansas & Texas at Parsons, Kan., has been appointed master mechanic of the Chicago Great Western at Oelwein, Iowa, succeeding A. B. Clark.

F. W. OAKLEY has been appointed master mechanic of the Eastern Kentucky division of the Louisville & Nashville, with office at Ravenna (Ky.) shops, succeeding Harry S. Hills, deceased.

T. F. RYAN has been appointed assistant master mechanic of the Cincinnati terminals and Kentucky division of the Louisville & Nashville, with office at Central Covington (Ky.) shop.

T. R. STEWART, master mechanic of the Baltimore & Ohio at Connellsville, Pa., has been transferred as master mechanic to Cumberland, Md.

L. TEAGUE has been appointed acting master mechanic of the Cuba Railroad at Santiago, Cuba.

J. URGELLES has been appointed master mechanic of the Cuba Railroad at Camaguey, Cuba.

W. WELLS, district master mechanic of the Canadian Pacic, with office at Schreiber, Ont., has been transferred in the same capacity to the Farnham division of the Quebec district.

W. WRIGHT, division master mechanic of the Canadian Pacific, with office at Toronto, Ont., has been transferred as division master mechanic to Brownville Junction, Me., replacing C. Powers, who has been made division master mechanic at Toronto.

SHOP AND ENGINEHOUSE

J. S. ALLEN has been appointed general foreman of the locomotive erecting shop of the Canadian Pacific at North Bay, Ont.

F. W. FRITCHEY, of the Division of Locomotive Inspection, Interstate Commerce Commission, District 15, has been appointed superintendent of shops of the Wheeling & Lake Erie, with headquarters at Brewster, Ohio.

J. O. WAYCROFT, gang foreman of the Chicago Great Western at Oelwein, Iowa, has been promoted to day roundhouse foreman, succeeding Clifford Cade.

PURCHASING AND STOREKEEPING

C. C. KEEBLE, recently storekeeper of the Gulf, Colorado & Santa Fe, at Galveston, Tex., has received a commission as first lieutenant in the quartermaster's corps, at Washington.

M. C. MOLES has been appointed storekeeper of the St. Louis division of the Chicago, Rock Island & Pacific, with headquarters at St. Louis, Mo., succeeding F. E. Hartzler, who has enlisted in the 49th Regiment, U. S. Railway Engineers.

JOHN STAMMERS has been appointed storekeeper of the Kansas division of the Chicago, Rock Island & Pacific, at Herington, Kan., succeeding J. E. Thomas, resigned.

GEORGE G. YEOMANS, general purchasing agent of the New York, New Haven & Hartford, and G. W. Hayden,

assistant purchasing agent, now have supervision and management of both the purchasing and stores departments which were recently consolidated and are known as the supply department, with headquarters at New Haven, Conn. The supply agents, Lines East and West, will co-operate and rank with maintenance engineers and mechanical superintendents. The division supply agents will co-operate and rank with division master mechanics and division engineers.

OBITUARY

Stephen L. Bean, mechanical superintendent of the Atchison, Topeka & Santa Fe Coast Lines, died at Los Angeles, Cal., on March 24. He was born in Franklin county, N. Y., on March 26, 1854. He learned the machinist trade in the Manchester Locomotive Works and entered railway service with the Wisconsin Central in 1874. He was afterwards employed as machinist and foreman by the Chicago, St. Paul, Minneapolis & Omaha, at North Hudson, Wis., the St. Paul & Duluth at St. Paul, Minn., and the Northern Pacific. In February, 1881, he was made foreman of that road in charge of locomotives and equipment engaged in construction work in western North Dakota, which position he held until March 1, 1882. On that date he was appointed master mechanic at Glendive, Mont., was later transferred to Fargo, N. D., and from September 1, 1893, to November 1, 1902, he was master mechanic at Brainerd, Minn. On November 1, 1902, he was appointed shop superintendent of the Northern Pacific at Brainerd. Since June 10, 1903, he has been with the Atchison, Topeka & Santa Fe, originally as master mechanic at Albuquerque, N. M., and on April 20, 1904, was appointed mechanical superintendent of the Coast Lines, which position he held until the time of his death.

Frank Eicher, who for many years previous to his retirement in 1912, held the position of general foreman of the coach yard of the Big Four at Cincinnati, died on April 2. Mr. Eicher had a record of 50 years continuous service with the Indianapolis & Cincinnati and its successor, the Big Four.

H. S. Hills, master mechanic of the Louisville & Nashville, with office at Ravenna, Ky., died recently at his home in Irvine, Ky., at the age of 52.

A. E. Hutchinson, general purchasing agent of the Oregon Short Line, with headquarters at Salt Lake City, Utah, died in that city on April 3.

Charles D. Porter, master mechanic of the Pennsylvania Railroad, at Pittsburgh, Pa., died in that city on May 2, at the age of 35.

Henry Russell Lloyd, fuel agent of the Chicago, Milwaukee & St. Paul until his retirement in 1910, died at his home in Chicago on April 12.

NEW SHOPS

Florida East Coast.—This company is building a paint shop at St. Augustine, Fla., to cost about $15,000. The structure is to have a wood frame with slate roof and will be one story high, 88 ft. wide and 100 ft. long. The work is being carried out by company forces.

Philadelphia & Reading.—A contract has been given to the William Steele & Sons Company, Philadelphia, Pa., for building a steel and concrete engine house at Philadelphia, part circular, and to contain 10 stalls 90 ft. long and 6 stalls 110 ft. long, also to build a machine shop of irregular shape. The latter will be 130 ft. wide at one end and 156 ft. 6 in. at the other by 216 ft. 7 in. long. The cost of the work will be about $326,183.

Supply Trade Notes

The Certes Supply Company, St. Louis, Mo., has been appointed selling agent for the Burden staybolt and engine bolt iron, and iron rivets in St. Louis and territory tributary thereto.

Thomas Finigan was elected a vice-president of the American Brake Shoe & Foundry Company, with headquarters at Chicago, at a meeting of the board of directors of that company on May 20.

McCord & Co., Chicago, have purchased several parcels of property in the vicinity of 112th and Green streets, Chicago. The property is adjacent to the company's present plant and will be used for future extensions.

H. D. Wright, manager of the San Francisco office of the Brown Hoisting Machinery Company, has been appointed Pacific coast representative, succeeding the Colby Engineering Company in the northwest territory. Mr. Wright's offices are in the Monadnock building.

The Southern Railway Supply & Equipment Company, St. Louis, Mo., announces the purchase of the car seat department of the Scarritt-Comstock Furniture Company, and the reorganization of that end of the business as the Scarritt Car Seat & Manufacturing Company.

George A. Post, Jr., western representative of the Standard Coupler Company, has received a commission as captain in the Ordnance Department. Mr. Post graduated from Cornell University in 1905, and has been connected with the railway supply field since graduation.

William F. Cutler has been elected president of the Southern Wheel Company, with headquarters at St. Louis, Mo., succeeding W. G. Pearce, who now becomes chairman of the board of directors; and Frank C. Turner was elected vice-president in charge of sales with office at St. Louis.

The Q & C Company announces that it has taken over the manufacture and sale of packing and lubricating under the Thomas Smith patents, formerly controlled by B. M. Jones & Co., of Boston. These devices will be hereafter known as the Q & C packing and Q & C lubricating.

R. G. Stutsman, for a number of years superintendent of the frog and switch shop of the Chicago, Milwaukee & St. Paul at Tomah, Wis., and more recently master mechanic of the Four Lakes Ordnance Company, Madison, Wis., has been appointed sales representative of Manning, Maxwell & Moore at Milwaukee, Wis.

J. M. Riordan until recently sales engineer of the Grant Lees Gear Company, of Cleveland, Ohio, and formerly representing the Fellows Gear Shaper Company, of Springfield, Vt., in the central states, is now connected with the sales organization of the Cleveland Milling Machine Company, 18511 Euclid avenue, Cleveland, Ohio.

Stephen C. Mason of the McConway & Torley Company, Pittsburgh, Pa., was elected president of the National Association of Manufacturers at a meeting of the board of directors held in New York, May 23, following the three-day convention. Mr. Mason is the seventh president of the association. He succeeds Colonel George Pope, who died April 19 last.

The property and plants of the Lehigh Foundry Company and the Lehigh Car, Wheel & Axle Works, of Fullerton, Pa., have been merged into one organization, the Fuller-Lehigh Company, with office and works at Fullerton, Pa. The properties of the two companies are adjoining and have been for a number of years under the same man-

agement. The change is one of name only. The executive personnel remains the same.

Press G. Kennett, Southern Railway sales manager for the Flint Varnish & Color Works, with headquarters at St. Louis, Mo., has been appointed western railway sales manager, with headquarters at Chicago, succeeding Rex W. Hudson, resigned to engage in other business. J. C. Jonas has been appointed southern railway sales manager at St. Louis, succeeding Mr. Kennett.

William Dewar Ellis, who was president of the Schenectady Locomotive Works when it was merged with the American Locomotive Company some years ago, died at his home in New York on May 23, aged 63 years. His father, John Ellis, was one of the founders of the Schenectady Locomotive Works, and Mr. Ellis succeeded his brother in the presidency of the corporation. He retired about fifteen years ago.

H. S. Patterson has been appointed manager of the railroad department of the Walworth Manufacturing Company, with headquarters in Boston, Mass.; H. T. Goodwin has been appointed assistant manager of the railroad department, with headquarters in New York. Both Mr. Patterson and Mr. Goodwin obtained their training with the National Tube Company by taking the specialty course at the Kewanee works of the National Tube Company, now the Walworth Manufacturing Company.

The Curtain Supply Company, owing to the growth of business and the need of increased space, has leased almost the entire building at 350-356 West Ontario street, Chicago, and has been located there since June 1. The new quarters of the company will be about 50 per cent larger than the old. The building is new and in addition to being equipped with greater and more efficient manufacturing facilities, will have a private track for shipping and receiving freight. For about 19 years this company has been located at 320 West Ohio street, Chicago.

Edward Buker has been appointed western representative of Rome Iron Mills, Inc., with office in the McCormick building, Chicago. Mr. Buker was born in Chicago in 1885. He received his education in the public schools of that city and at the University of Illinois, from which institution he received the degree of Mechanical Engineer. While at college his summer vacations were spent in the South Chicago rolling mills. Immediately upon graduation from college Mr. Buker entered the service of the Pullman Company as apprentice in that company's car shops in Chicago. After serving his time he went as special apprentice in the locomotive shops of the Illinois Central. Two years later he accepted a position as inspector on the Chicago, Rock Island & Pacific and was later appointed general foreman on the same road. Leaving the Rock Island he went with the Missouri, Kansas & Texas as master mechanic. During the past two years he has been with the Galena-Signal Oil Company as mechanical expert, which position he held up to the time of his recent appointment.

E. Buker

The Ohio Electric & Controller Co., 5900 Maurice avenue, Cleveland, Ohio, has been incorporated with a capital stock of $200,000 for the purpose of manufacturing lifting magnets and electrical controlling devices. Lifting magnets will be built at once and controlling devices later. The officers of the new company include F. W. Jessop, president; W. B. Greene, vice-president, and A. D. Walter, secretary and treasurer. Mr. Jessop was formerly works manager of the Electric Controller & Manufacturing Company, Cleveland. He has had an extensive experience in the manufacture of lifting magnets and electrical apparatus for the control of motors.

Holmes Forsyth, second vice-president, secretary and general manager of the Curtain Supply Company, Chicago, was elected president at a meeting of the directors on April 30. Randolph S. Reynolds, assistant to the general manager, was elected secretary to succeed Mr. Forsyth.

Mr. Forsyth has been actively connected with the Curtain Supply Company since its organization in 1899, having at that time been elected second vice-president and secretary of the company, which offices he continued to hold until his recent election as president, succeeding Edward T. Burrowes, who died on March 19, at his home in Portland, Me.

H. Forsyth

Mr. Burrowes had been the president of the company since its organization on May 19, 1899, at which time the E. T. Burrowes Company, the Adams & Westlake Company, and the Forsyth Brothers Company, sold out their curtain departments to the new concern which was designated the Curtain Supply Company. Mr. Burrowes was therefore connected with the car curtain industry from its very beginning, being president of the first company that ever put on the market an American car window curtain.

Mr. Reynolds has been with the Curtain Supply Company since 1912. Prior to that date he was with the Western Steel Car & Foundry Company, at Anniston, Ala., and with the Pressed Steel Car Company, of Pittsburgh, Pa., having been connected with their purchasing department from 1905 to 1912, at which time he resigned to go with the Curtain Supply Company.

At a meeting of the stockholders of the Joseph Dixon Crucible Company, held on April 15, the following were elected officers of the company: George T. Smith, president; George E. Long, vice-president; J. H. Schermerhorn, vice-president; Harry Dailey, secretary; William Koester, treasurer, and Albert Norris, assistant secretary and assistant treasurer. The American Graphite Company, a subsidiary of the Joseph Dixon Crucible Company, held its annual meeting on the same day. George T. Smith and George E. Long were also elected president and vice-president, respectively, of this company; J. H. Schermerhorn, treasurer, and Harry Dailey, secretary.

Frank Hopewell, head of the firm of L. C. Chase & Co., Boston, Mass., died April 25, at the age of 61. Mr. Hopewell was born in Shelburne Falls, Mass., in 1857. His father, a native of London, England, came to the United

States at the age of 14 and settled in Springfield, Mass., where his son, Frank, graduated from the Springfield High School in 1875, and the Springfield Collegiate Institute in 1879. In 1881, Frank Hopewell became associated with L. C. Chase & Co., of Boston, selling agents for Sanford Mills, Troy Blanket Mills, Reading Rubber Manufacturing Company, and Holyoke Plush Company, becoming a partner in 1887. He became treasurer of Sanford Mills in 1896, holding this office until 1915.

Lieut. Colonel W. R. Roberts, announcement of whose promotion from Major to Lieut. Colonel in the Construction Division of the United States Army was made last month, is president of Roberts & Schaefer Company, Chicago. Colonel Roberts has been in engineering construction work for 30 years, and about 20 years ago organized the Roberts & Schaefer Company, which specializes in coal mining plants, coal washeries, coal docks, etc. He is still president of this company, although he has been giving all of his service to the government since last October. The Construction Division of the Army, with which Colonel Roberts is connected, is the outgrowth of the old Cantonment Division which was organized for the purpose of building the 16 National Army camps and the 16 National Guard camps. The variety and character of the work of the Construction Division are much greater than were those of the old Cantonment Division. While the Construction Division is still building some cantonments for the Signal Corps and the Engineer Corps and making extensive additions to all the original cantonments, its most important work at present is the building of large ordnance plants, powder manufacturing plants, Quartermaster Corps, terminals, Quartermaster interior depots, many large hospitals, etc. Indeed, this division does all the construction work for the United States and its possessions, for all divisions or bureaus of the Army, and it now has a construction program on hand which amounts to about $650,000,000. It is divided into six branches, engineering, construction, materials and transportation, contract and administration. Colonel Roberts is executive officer in charge of the construction branch, which is the largest and most important branch and which now employs about 200,000 men. Colonel Roberts was a graduate of the University of Illinois. His success in his business, as well as in his new work, has been due not only to his skill as an engineer, but to his ability as a business organizer.


Lieut. Col. Roberts

Independent Pneumatic Tool Company

A re-organization has been effected of the Independent Pneumatic Tool Company, a New Jersey corporation, and the Aurora Automatic Machinery Company, which is incorporated in Delaware. Both companies were owned by the same interests, the Independent Pneumatic Tool Company, representing the selling division for the Thor pneumatic and electric tools, and the Aurora Automatic Machinery Company being the manufacturing department. The latter company also manufactures and sells Thor motorcycles and gasoline engines.

The combining of the two companies under one corporate name is for convenience in handling business.

Under the re-organization plans the company is known as the Independent Pneumatic Tool Company, incorporated in Delaware for $3,000,000. Ten directors will serve on the board as follows: John P. Hopkins, former mayor of Chicago, chairman; John D. Hurley, James J. McCarthy, William A. Libkeman, Leonard S. Florsheim, Edward G. Gustafson, Robert T. Scott, Ralph S. Cooper, August Gatzert and Fletcher W. Buchanan.

The officers are John D. Hurley, president; Ralph S. Cooper, vice-president; Fletcher W. Buchanan, secretary and Edward G. Gustafson, treasurer.

The general offices of the company are in the Thor building, at 1307 South Michigan boulevard, Chicago.

Chicago Pneumatic Tool Company

The following changes in the organization of the manufacturing and sales departments of the Chicago Pneumatic Tool Company have been effected by H. A. Jackson, the company's new president: W. H. Callan, manager of the company's two compressor plants at Franklin, Pa., has been appointed general manager of plants, with headquarters in Chicago. W. P. Pressinger, manager of the compressor and engine departments at Chicago, has been appointed general manager of sales, with the same headquarters. H. D. Megary, previously with the Bethlehem Steel Company, South Bethlehem, Pa., has been made assistant to the president at Chicago. G. A. Rees, general purchasing agent, has been promoted to manager of purchases and stores at Chicago. These officers report directly to the president.


W. P. Pressinger

In addition, the following changes have been made in the sales department. These officers, most of whom formerly reported directly to the president, will hereafter report to the general manager of sales and will constitute his staff: J. C. Osgood, manager of the pneumatic tool sales division; C. B. Coates, manager of the electric tool sales division; H. L. Dean, manager of compressor sales division, formerly assistant manager of the compressor department at New York; B. R. Hawley, manager of engine sales division, formerly assistant manager of the engine department at Chicago; T. J. Hudson, manager of the motor truck sales division. All of these men will have headquarters in Chicago. The above appointments were effective May 27.

W. P. Pressinger, who has been promoted to general manager of sales, was born in New York City on September 27, 1871. In 1887, he entered the employ of the Clayton Air Compressor Works, New York. He remained with that company for 13 years, rising to the position of manager of sales. In 1900 Mr. Pressinger organized the New York Air Compressor Company of which corporation he was secretary and general manager. In the following year the company was assimilated by the Chicago Pneumatic Tool Company. Mr. Pressinger was manager of the compressor department of that company up to the time of his appointment as general manager of sales, as afore-mentioned. He is also president of the Compressed Air Society.

CATALOGUES

RED CROSS CIRCULAR.—E. S. Jackman & Co., Chicago agents for the Firth-Sterling Steel Company, are sending out an attractive folder prepared by Edwin S. Jackman in the interests of the American Red Cross.

VALVE GEAR.—"The Baker Locomotive Valve Gear" is the title of a booklet issued by the Pilliod Company, Swanton, Ohio, describing the locomotive valve gear of that name. Definitions are given of the various valve terms and the principle of operation, together with a description of the method of valve setting.

SMOOTH-ON IRON CEMENT.—The sixteenth edition of the "Smooth-On" instruction booklet, issued by the Smooth-On Manufacturing Company, Jersey City, N. J., contains 144 pages, each one with an illustration showing in an interesting manner how the different "Smooth-On" iron cements are used for repairing purposes.

SMALL TOOLS.—The small tools department of the Pratt & Whitney Company. Hartford, Conn., has issued catalogue No. 9 covering the taps, dies, milling cutters, reamers, punches, drills, etc., manufactured by that company. The catalogue has 315 pages, 4½ in. by 7½ in. and in the miscellaneous section in the back there are several valuable tables.

TOOLS.—The Warren Tool & Forge Company, Warren, Ohio, has issued a 32-page catalogue, illustrating and indexing the special line of hand tools manufactured by that company. These consist of picks, crow bars, lining bars, various heavy hammers, axes, rail and tie tongs, wrenches, chisels, etc. Many different forms of each tool are illustrated.

DRIVING BOX LUBRICATION.—The Franklin Railway Supply Company, Inc., New York, has issued bulletin No. 500 describing the Franklin automatic driving box lubricator. Instructions are given for applying the lubricator, also for its proper inspection and care, and in connection with the lubricator, a special method of grooving the brasses is described and recommended.

BALANCED DRAFT.—The Engineer Company of New York has issued bulletin 16 entitled "Balanced Draft," giving an analysis of combustion conditions and boiler operation when nearly atmospheric pressure is maintained in the furnace chamber. Bulletin No. 18 issued by the same company explains in detail the advantages of balanced draft and describes the apparatus necessary to maintain it.

KEYSTONE QUALITY.—The Keystone Manufacturing Company, Buffalo, N. Y., has issued a 40-page booklet describing and illustrating the line of ratchets for both drills and wrenches manufactured by that company. Prices and dimensions for ratchets designed for various purposes are shown as well as the auxiliary parts used. Several pages are devoted to cataloging the various styles of Westcott adjustable S-wrenches.

BOILER METERS.—In bulletin No. 41, issued by the Bailey Meter Company, Boston, Mass., and entitled "How to Save Coal," there is considerable useful information regarding boiler capacity, efficiency and the amount of air necessary for complete combustion. Bailey meters give continuous records of steam flow, air flow and temperature variations, and this bulletin points out the necessity of such records for efficient boiler operation.

TRUCK BATTERY CHARGING.—Publication No. 234, issued by the Cutler-Hammer Manufacturing Company, Milwaukee, Wis., is a six-page illustrated folder describing the C-H sectional battery charging equipment for industrial electric trucks, which has been extensively used in public and private garages. Two pages are devoted to illustrating a number of large and small equipments in industrial establishments, piers and railroad terminals.

AN INVESTIGATION OF PIPE CORROSION.—This is the title of Bulletin No. 30, issued by the A. M. Byers Company, Pittsburgh, Pa. The investigation was prompted by local agitation on the part of property owners in Pittsburgh, due to the difficulty of maintaining hot water pipe lines. It involved an investigation of the condition of hot water pipes in 125 apartment buildings in the city of Pittsburgh, and the data is arranged to show a comparison of the life of wrought iron and steel pipes.

PUMPS FOR CUTTING COMPOUND.—The Fulflo Pump Company, Cincinnati, Ohio, has recently issued a bulletin describing the impeller type of pump for the distribution of coolant which this company manufactures. It has also prepared for free distribution a booklet entitled "The Scientific Lubrication of Cutting Tools." This booklet gives a short history of cutting tool lubrication and describes the methods of application of cooling compounds which have been found most effective in increasing the life of tools.

INDUSTRIAL LIGHTING.—The importance of proper lighting as an aid in securing the maximum production in the shops is well brought out in a booklet published by the Cooper-Hewitt Electric Company, Hoboken, N. J., under the title, "Lighting for Production and Safety." The intensity of illumination, system to be used, character of light source and units, are discussed and the application of the principles set forth is illustrated by several drawings showing typical lighting arrangements as installed in various manufacturing plants.

PACKINGS AND MECHANICAL RUBBER GOODS.—Jones Packings is the title of a 28-page catalogue which has been issued by the Jones Packing Company, 50 Church street, New York. A complete line of fibrous packings for oil, ammonia, steam, acid, water, syrup, air, alkali, etc., is illustrated and briefly described, with price quotations. The line includes ring, spiral and coil packings of various sections and types of construction; sheet packing; asbestos, duck insertion and tubular gaskets; pump valves, water and steam hose; diaphragms, etc.

"MY DEAR JIM."—This is the title of a small booklet issued by the Carnegie Steel Company in the form of a letter from a retired steel man to a friend in Medicine Hat. The letter tells in entertaining language of the growth of the Carnegie Steel Company during the last 20 or more years, both as to the extent of its plants and the variety of its products. Following the general outline of the latest Carnegie Shape Book, detailed information is given concerning the various sections rolled for structural and industrial purposes, giving the trade reasons for introducing the newer sections.

STONE-FRANKLIN LIGHTING EQUIPMENT is the title of an instruction book and part catalogue just issued by the Franklin Railway Supply Company, Inc., 30 Church street, New York. The first part of the book contains illustrations and wiring diagrams of the different types of Stone-Franklin car lighting equipment. Following this there is given information pertaining to terminal inspection, some condensed maintenance information, instructions for the application of generators and detailed statements of the principal features to be observed in operating and maintaining the equipment. The latter part of the book is given over to a complete list of parts. Cross-section drawings of the generators show exactly where these parts are located. The book contains many illustration and will be found to be of much value to all users of Stone-Franklin lighting equipment.